POWER PLANT ENGINEERING

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Power Station at Mark Plant

SECOND ARTICLE ON THE POWER PLANT OF THE STEEL & TUBE CO. OF AMERICA AT ITS NEWEST WORKS, DEALING WITH TURBINE GENERATORS AND BLOWERS, CONDENSING SYSTEM AND ELECTRIC FEATURES. BY GORDON FOX

THE POWER STATION at Mark Plant of the Steel & Tube Company of America is a building of steel construction 220 ft. long and 63 ft. wide. The walls are of expanded metal and cement plaster with a liberal window area provided with Fenestra steel sash. The roof is of hollow cement tile with three-ply asbestos covering thoroughly tarred. The building is located parallel to the boiler house, the equipment of which was described in the Dec. 15, 1918, issue, but separated therefrom by a 40-ft. aisle, previously mentioned in the description of the boiler house. A leanto or wing 132 ft. long and 25 ft. wide runs along the side away from the boiler house, this space housing the electrical switching equipment.

The operating floor of the power station is 24 ft. 6 in. above normal lake level and 8 ft. 6 in. above the yard. On this level are located the main generating units and blowers.

The present electric generating equipment comprises two 6250-kv.a., 3-phase, 60-cycle, 2300-volt, 3600 r.p.m. turbine generators and a similar unit of 12,500 kv.a. capacity running at 1800 r.p.m. Space is provided for two additional units of 12,500 kv.a. capacity, one of which may be installed at an early date. These units were built by the Westinghouse Companies. The two smaller units are of the duo-flow type, the larger is of the uni-flow type. Each turbine governor is equipped with a motor to permit speed control from the switchboard to facilitate synchronizing. A Frahm vibrating reed

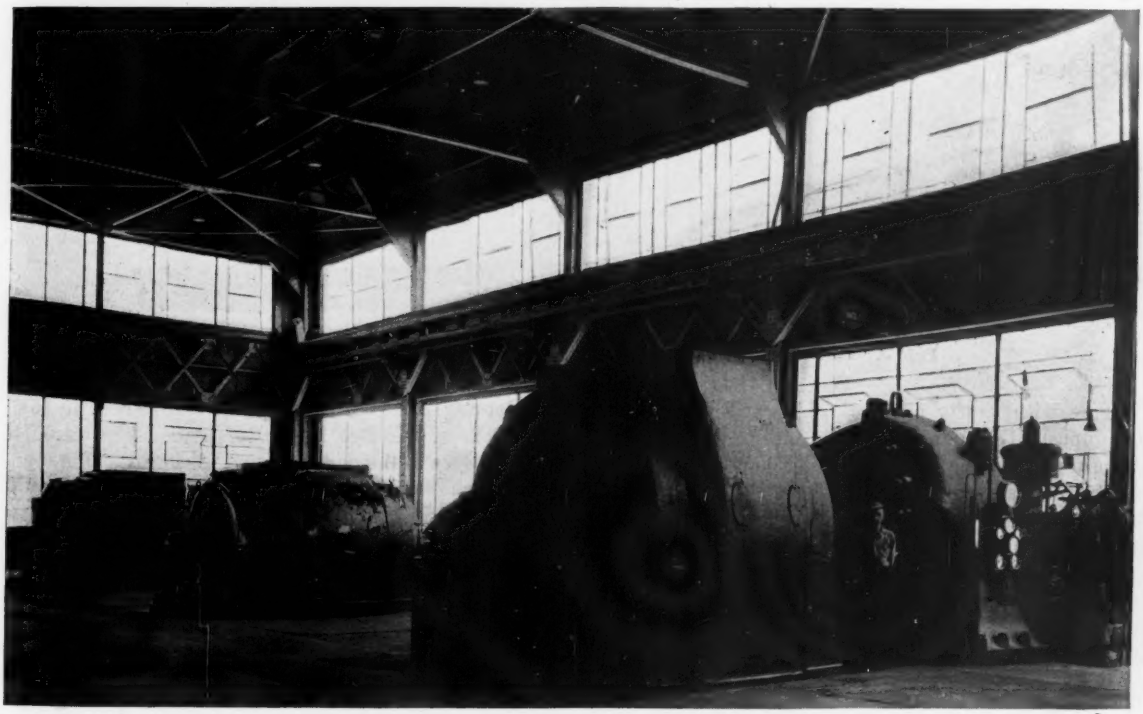


FIG. 1. ELECTRIC GENERATING UNITS IN MARK PLANT

tachometer is attached to the frame of each turbine, together with several steam pressure gages and a vacuum gage. Each generator is equipped with thermo-couples embedded in the stator windings. These indicate internal temperatures and enable loading the machines to maximum safe limits, but prevent operating beyond safe insulation temperatures.

They also serve to indicate the condition of the windings and ventilating ducts in the matter of cleanliness. A single potentiometer is used with the thermo-couples on all units, dial switches being used to transfer the instrument between the various couples.

In addition to the electric generating units there are installed on the main operating level of the power station two 55,000-cu. ft. per minute turbine blowers. These deliver air at 13 lb. pressure, this air being conducted through an aerial line outside of the power house to the blast furnace for the furnace draft. These units comprise Ingersoll Rand 3000-hp., 2500 r.p.m. uniflow turbines and 5-stage blower units. These machines are operated singly.

All the turbine generators and blowers are installed beneath the turbines and are connected therewith by expansion joints. The condensate pumps are located on the basement level, which is 5 ft. above normal lake level and 19 ft. 6 in. below the operating level of the station. The comparatively great headroom in the basement was necessitated by the use of this type of condenser. The three condensers of the present turbine generator units discharge into one hot well located in the subway between boiler house and power house. The two turbo blowers discharge into a second similar hot well. A third hot well, of like design, will be provided for the future generating units. These hot wells are interconnected and a weir in one of them maintains the water at the desired height, the excess water passing to the sewer.

The service water and condensing water for the plant is obtained from Lake Michigan through a covered intake canal 5 ft. wide and 8½ ft. deep. This canal is now 800 ft. long, but its length will be increased when more property is filled. Copper wire screens of No. 6 mesh supported on an angle iron frame are provided at the lake end of this intake to prevent the entrance of fish

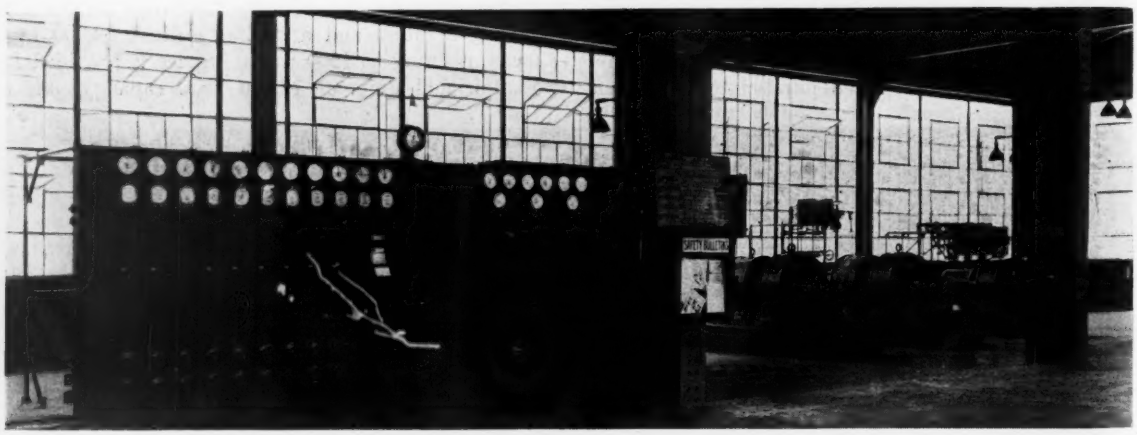


FIG. 2. MAIN SWITCHBOARD AND EXCITER UNITS IN MARK POWER PLANT

in a row with shafts parallel. Liberal space is provided opposite the ends of the machines for dismantling. The main aisle of the building, which houses this equipment, is served by a 25-ton overhead electric traveling crane with 15-ton auxiliary hoist. Several removable sections are built into the floor of this level, giving access of the crane to pumps and auxiliaries in the basement below. As all piping is in the basement there is a clear headroom on the operating level above all machines, giving easy access of the overhead crane.

All the main units enumerated above are operated full condensing at all times, although an atmospheric relief valve is provided for each unit for safety and emergency use. Atmospheric exhaust of the three generators is provided by a 36-in. pipe leading outside of the building. A similar atmospherie exhaust is provided for the blowers. Individual Le Blanc jet condensers are provided for each turbine generator and turbine blower. The condensate pumps for these units are operated by small, noncondensing turbines driving through reduction gears. The condensers are located directly and debris. A section of the canal will be seen in Fig. 2, page 982, of the Dec. 15, 1918, issue. This canal has two branches in the power station basement. One branch extends the entire length of the building, along the wall next to the boiler house subway. All the condensers obtain condensing water from this branch. As there is very little suction lift, no pumps are necessary to supply injection water to the condensers. Water from the service standpipe is used to establish the vacuum in the condensers after which time they will draw their water from the intake canal.

The second branch of the intake canal extends across the basement of the station near one end. From this branch the various service pumps obtain their supply. The intake piping of these service pumps is so arranged, however, that they may also obtain water from the hot wells, there being an excess of water in the hot wells flowing into the sewer.

All of the service pumps are of the centrifugal type. Two pumps, of 4200 g.p.m. and 7700 g.p.m. respective capacities, are driven by steam turbines operating non-

condensing. There are four motor driven pumps, one of 4200 g.p.m. capacity and three of 7700 g.p.m. capacity. This series of pumps will supply service water, not only for Mark plant, but also for the By-Products Coke Co.'s plant, the water for the latter being carried through a 30-in. line a distance of about 2000 ft. A standpipe or elevated tank for storage of service water for Mark plant is located adjacent to the power station. The capacity of this standpipe is 150,000 gal. The head is 100 ft. The present water consumption of Mark plant is about 20,000,000 gal. per day.

Induced ventilation of the turbine generator units is obtained through the medium of small fans on the rotor shafts. This air is taken from the basement of the power house and passed through Spray air washers, located on the basement level near the generator foundations. One 50,000-cu.-ft.-per.-minute washer serves the two smaller generators and another duplicate washer serves the larger generator. Dampers are installed in the air intakes between washers and generators to direct the air for the smaller units and to make it possible to shut off the air to prevent spreading of damage to the generator windings due to an arc fanned by the blast. The water for the air washers is taken from the plant service lines and discharged into the intake. Each washer requires about 500 g.p.m.

A considerable quantity of compressed air is required about the mills. To furnish this air for the district adjacent to the power house there is installed, on the basement level, an Ingersoll Rand 16-in. and 10-in. by 14-in. duplex compressor of approximately 600 cu. ft. free air capacity, equipped with unloading valves. This compressor is driven through a short belt with idler pulley by a 100-hp. slip ring induction motor. The motor is provided with magnetic control arranged in connection with a pressure switch. When the pressure drops to 85 lb. the motor starts and the compressor runs until a pressure of 105 lb. is reached. The motor then stops. A storage and receiver tank of 500 cu. ft. capacity is used in conjunction with this equipment.

Excitation for the turbine generators is supplied by separate units, which are located in the electrical wing on the operating level. One 50-kw., 230-volt steam turbine driven exciter is provided for starting and emergency operation. Two 90-kw. induction motor generator sets are now installed and an additional 150-kw. induction motor generator set will be installed simultaneously with No. 4 alternator unit. This arrangement permits efficient operation with any combination of main units in service and also furnishes excitation for the entire alternator capacity with any one exciter shut down.

The main switchboard is of the vertical panel remote electric control type and is located on the operating floor in the electrical wing. Two sets of exciter busses are provided on the switchboard, making possible the independent operation of main units. An automatic voltage regulator is provided for each exciter bus, this being so arranged that any exciter may be used on either bus with the corresponding regulator.

In the rear of the main switchboard are located the alternator rheostats, which are operated by motors or solenoids controlled from the switchboard. Aluminum cell lightning arresters, one for each main bus, are located near the alternator rheostats.

Beneath the switchboard is a cell structure room, the floor of which is on an intermediate level between operating floor and basement. The cell structure, which contains the solenoid operated oil switches and mechanisms, is of reinforced concrete, with conduits embedded in the structure. Transite is used for barriers between busses. The switching system is laid out on the double bus ring principle. The busses are not sectionalized by reactance, each of the main oil switches being able to rupture a short circuit with full station capacity behind it. The oil switches comprise three single pole units isolated by concrete barriers, the three poles being operated by a single solenoid controlled from the switchboard. Lock type disconnect switches are provided above and below the oil switches to permit their isolation for repairs.

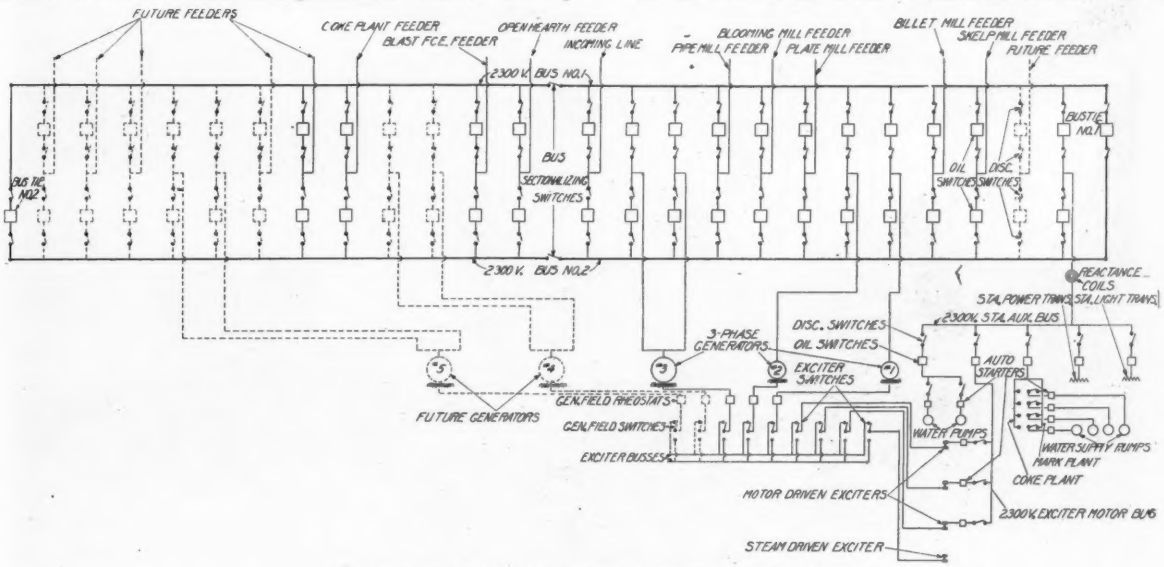


FIG. 3. LINE DIAGRAM OF ELECTRIC DISTRIBUTION SYSTEM

The oil switches for the main generating units are of the non-automatic type. The feeder oil switches provide protection against overloads through the use of inverse time element relays. These relays are provided both at the power house and at the substations. They have an adjustable time feature and are so adjusted that a severe short circuit will cause immediate opening of the feeder oil switch at the power house, whereas lesser overloads are cleared by the smaller feeder oil switches at the various substation switchboards. This arrangement prevents interruption of main feeders except by severe overloads which the substation switches cannot safely handle.

The double bus arrangement permits division of the power house capacity into two systems and makes possible a division of the load or the isolation of a feeder giving trouble. A contract exists with the local central station for breakdown and off-peak service. Sufficient power may be taken to operate lights, exciters, water pumps, stoker motors and other drives which must be kept in continuous operation to prevent damage to equipment driven. Through use of the double bus system, this service may be handled separately while the main units are manipulated.

Care has been taken to provide continuous operation of the exciters. One main feeder oil switch controls all auxiliary electric drives in the power house and boiler house. This feeder passes through reactors which limit a short circuit surge to 5000 kv.a. The circuit is then broken up by a station auxiliary switchboard. There are separate feeders from this board to the exciters, pumps, power transformers and lighting transformers. The oil switches provided for each drive have instantaneous trip overload protection and are capable of rupturing 5000 kv.a. The oil switches on the auxiliary panels have a short time setting and the main station feeder oil switch will open only under a prolonged short circuit. With this arrangement any overload is quickly cleared without interruption of the main station feeder.

The station auxiliary switchboard is located at one end of the electrical wing on the operating level. There are also located at this point some power and lighting distribution panels. It may be of interest to note that, in addition to the regular lighting system, an emergency lighting system is provided in the boiler house and power house, this system being capable of operation from the exciter bus in case of failure of the main power system.

Electric power is transmitted from the power house to the various mill substations entirely underground. Beneath the cell structure room in the power house is situated a cable distributing room. At this point the underground cables terminate in pot heads and are connected to their respective feeder sections of the bus structure. Power is transmitted to the various substations at 2300 volts alternating current. At each substation is located the necessary transformers and converting apparatus to step down and convert the power for that mill or district. This arrangement affords a simple radial system, avoids transmission at several voltages, transmits the power economically at high voltage, minimizes general service interruptions and simplifies metering arrangements.

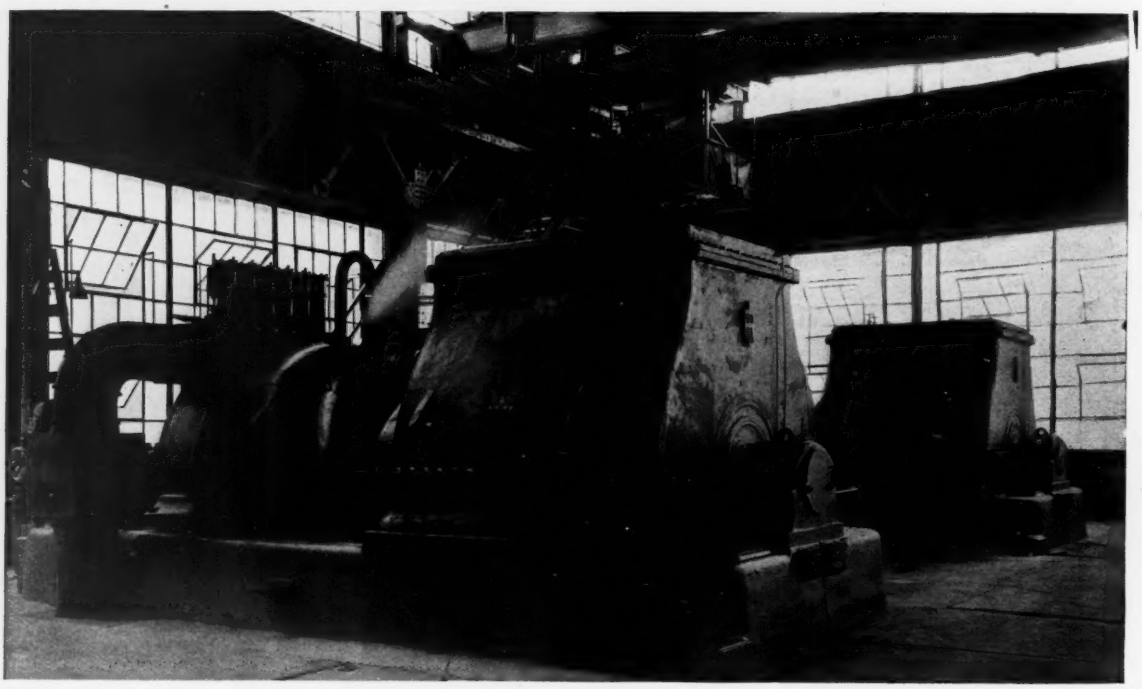


FIG. 4. TURBINE DRIVEN BLOWERS IN MARK PLANT

The steam plant and power station at Mark plant were designed and constructed under the direction of the company's engineers. The piping system, which is quite comprehensive, was furnished and installed by the Pittsburg Piping & Equipment Co. The station was put into partial operation about ten months from the date that the first piles were driven.

The Steam Condenser

GAIN BY CONDENSING, INFLUENCING CONDITIONS, CLEANING TUBES, COOLING WATER SYSTEMS. BY VICTOR J. AZBE

GAIN made by operation of prime movers and auxiliaries under vacuum is, under proper conditions, very great. Roughly speaking, there is as much power available below atmospheric pressure as there is above, which is more accurately illustrated in Fig. 1. This illustration is based upon theoretical figures, practically the power available will be a great deal less and will vary; as for example, less will be gained by a given vacuum in a single cylinder steam engine than in a two-cylinder compound or triple expansion engine or turbine.

Condensers are divided into a number of different types, the most commonly used is the surface condenser;

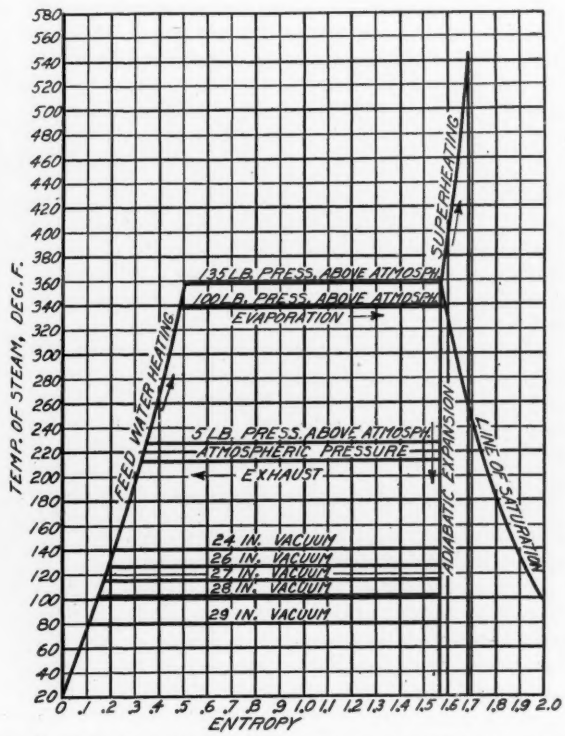


FIG. 1. ENTROPY DIAGRAM SHOW RELATIVE VALUES OF WORK DONE BELOW ATMOSPHERIC LINE

others are low level jet condenser and barometric condenser. The type to be preferred depends altogether upon conditions.

The performance of the surface condenser is dependent upon the amount of surface, amount of water circulated, temperature of water, velocity of water through the tubes, cleanliness of condenser surface, distribution of steam in condenser and efficiency of air removal.

Figure 2 illustrates proper relations of surface, water temperature and heat transmission based upon a heat transmission of 300 B.t.u. per square foot per degree difference per hour.

The greater the amount of water circulated, the better the vacuum, but the actual gain in economy has a limit, which should be carefully determined in each plant. With reciprocating engines, the first few inches of vacuum will represent the greatest gain, while with the succeeding, the benefit will grow less and less until finally there will be no further gain in spite of the higher vacuum, in fact there is liability of loss due to great increase of auxiliary power required for higher vacuum. With turbines, on the other hand, the gain will follow quite closely the theoretical curve and with the first few inches, it will be relatively slight as compared with gain obtained between 28 and 29 in. In fact, the limit of vacuum economical with turbines is not governed by the turbine, but rather by possibilities of cooling the water.

With reciprocating engines of the compound type, it never pays to go beyond 26 or 27 in., while with the single cylinder type, 22 in. is considered the limit advisable by the writer. This is due to the increase of initial condensation in the steam cylinder with greater temperature differences, and also due to impossibility of the

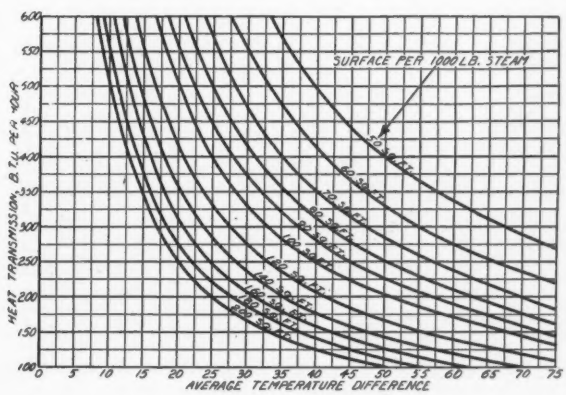


FIG. 2. CONDENSER HEAT TRANSMISSION, B.T.U. PER SQ. FT. PER HR. PER DEGREE DIFFERENCE IN TEMPERATURE

steam cylinder to cope with the tremendous volumes of steam when under rarefied pressure.

With the turbine the above does not hold true, since the problem there is reduced down to velocity only, for which turbines are admirably adapted. In fact, a turbine is far more efficient in its vacuum stages than high pressure elements.

The economical vacuum also depends a great deal upon the type of auxiliaries and their arrangement; some auxiliaries used are so uneconomical that it costs more to produce the vacuum than the gain realized by that vacuum. The use of the common duplex circulating pump especially should be strongly condemned.

Water availability, while important, is not paramount, since, in most cases, some kind of a cooling system has to be used anyhow. When water is used from flowing streams, great care should be taken that the pumping head is not too great. The pumping head very often is ignored with the resultant uneconomical installation, and it can not be over emphasized that when designing a plant extreme economy should be practiced and every foot of pumping head on the circulating sys-

tem saved that possibly can be. This policy should be extended to the cooling tower, and instead of having it of great height, lower ones covering more ground should be preferred.

The chief advantage of spray cooling systems next to low first cost is the greatly reduced pumping head.

When extreme pumping lifts are necessary, care should be taken to have such arrangement as to enable the balancing of one water leg against the other. But, with such installation, the water pressure on the condenser is great and leakage seriously aggravated. In such cases, double pumping systems are at times used, that is, pumping water to the condenser and again to the tower, but this requires two pumps, which increases power consumption and decreases dependability.

Heat Transfer

Heat transmission in a surface condenser will vary between 200 B.t.u. up to 900 B.t.u. in extreme cases. For ordinary approximate calculations and actual operating conditions a transmission of 300 B.t.u. per hour per sq. ft. per degree should be employed. When

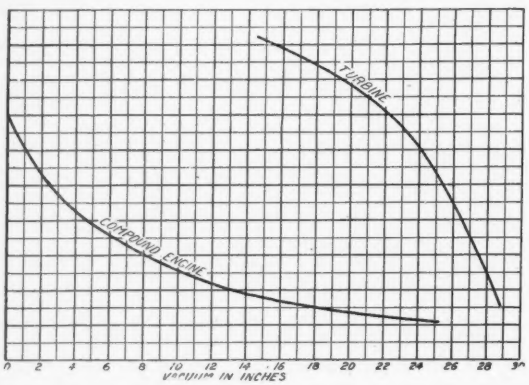


FIG. 3. EFFECT OF VACUUM ON RECIPROCATING ENGINE AND TURBINE WATER RATE

condenser is purchased, heat transmission should be included in the specifications and contract. In fact, the only true, equitable and dependable figure for performance of a condenser of the surface type is the heat transfer. Immediately upon installation of a condenser its performance should be carefully tested, when all the required information such as amount of steam, amount of water, temperature of water in and out, temperature of steam, temperature of condensate, water velocity, etc., are carefully recorded and heat transfer determined. Later on, the condenser performance should be checked at frequent intervals and compared with original results so as to determine if the standard is being kept up to.

Regarding heat transfer, this will increase with increasing water velocity and will approximately double when water velocity is increased four times; but the objection to high velocity, and consequently high heat transfer, is rapidly increasing friction or power requirement for auxiliaries. The power required for pumping water will vary as the cube of velocity.

In practice, velocity varies at between two to six feet per second but two is somewhat low. With too large condensers, the velocity often is even less and in such cases effort should be made to increase the one or two passes through the condenser to either three or four, which is not difficult in the present welding age.

Tube Size and Material

The customary size of condenser tubes varies from 5/8 in. up to 1¼ in., the latter being intended for dirty water. As far as heat transmission is concerned, the smaller diameter tubes are to be preferred. Tube material is generally either copper, bronze, aluminum bronze or Muntz metal. On board ship "Admiralty" mixture is generally used, consisting mostly of copper and zinc and a slight amount of tin.

The cleanliness of condenser surface is very important and any scale at all will greatly reduce the efficiency. The water while cold may be clear, but it is probably so saturated with inorganic matter that the increase of temperature while passing through the condenser causes precipitation of carbonates and formation of scale. Due to this, before putting in a condenser the characteristics of the circulating water should be known, and the more concentrated the water, the less should the temperature difference be. With cooling towers, even if the make-up water is not highly concentrated, the constant cooling of the water by evaporation is found to be the most favored spot for deposition of the salts.

To prevent scaling of condenser, make-up water should be treated before being admitted to the circulating system. Water in the system should be completely renewed frequently, or a blowoff system initiated the same as it is the case with the steam boilers.

Under no circumstances should circulating water from a cooling tower-condenser circulating system be used for boiler purposes. The fact that this water is warmer is fully offset by the fact that fresh water is far more pure and will not produce as much scale in the boiler.

Surface condensers can be cleaned by either the baking method, chemical method, brushing method or hammer method and cutting method.

With the baking method, steam is turned on at atmospheric pressure or slightly less, while no water is being circulated through the condenser. This process thoroughly dries the deposit and cracks it, which then can be washed out. If there is any difficulty in washing it out with a high pressure stream, then running a scraper through the tubes will clean the surface with facility.

The second method employs an acid that does not attack the metal. This acid must be diluted, since acid itself has no solvent power. This method is not to be advocated, since there is always more or less danger. The tubes being an alloy, there is liability that even if the acid does not attack the copper, it may attack the other metal, thus either destroying the tubes or causing them to become brittle and liable to leak.

The brushing method requires no comment, and is satisfactory for soft, but not hard scale.

The hammer method employs knockers operated in the same manner as used for boiler cleaning purposes.

In the cutting method, a very small turbine cleaner is used, a miniature reproduction of water tube boiler cleaner. This method is effective, but there is serious danger of injuring the tubes.

The greatest advantage of surface condenser over the other types is due to the fact that condensate is available for boiler feeding purposes. In some turbine installations there is remarkably little make-up water required for boiler purposes. The writer recalls especially one where only 4 per cent is needed and that 4 per cent is distilled. This enables them to operate a boiler for a whole year without internal cleaning.

In all plants the closest check should be maintained upon the amount of make-up water required and there should be extreme caution that no distilled water is being wasted needlessly.

Detecting Leaks

Tightness of surface condenser is paramount and frequent tests are required. To determine if the tubes are tight, the condensate should be titrated with a standard solution of silver chloride if the circulating water is salty, in which case potassium bichromate is to be used as an indicator. With alkaline circulating waters, a standardized solution of sulphuric acid with methyl arranged as indicator should be used.

Titration tests are of great value; with these a leak can be immediately discovered and it is possible even to judge how serious it is, and whether it is getting worse or not. Samples of condensate should be titrated frequently and results obtained recorded in the log book.

At times, vacuum in a plant gets poor and there is a scramble to discover the reason. I know a plant where before the writer arrived they painted every flange and joint in the whole exhaust line, thinking that air leak was the cause. Part of the line was in slightly poor condition and they wanted to abandon it at the expense of thousands of dollars. When he got there, by a simple test he demonstrated to them that it could not be the fault of an air leak, but rather because the centrifugal pump failed to circulate the proper amount of water.

In any case as the above, or when the performance of the vacuum pump is to be tested, determine pressure and temperature at given points in the steam space of the condenser and compare them with standard steam tables. If the pressure is more than the pressure corresponding to the temperature, then this discrepancy is due to air or other noncondensable gases in the condenser. This is due to a law which calls that when two or more gases or vapors are mixed in a given space, the total vapor pressure will be that resulting from adding their respective pressures at that particular temperature, multiplied by the percentage of space occupied.

The further advantage of the surface condenser over the low level jet and barometric is that in it only air in steam is to be removed, while in the others both the air in steam and also the air in the water.

It is the writer's opinion that in any plant where there is a surface condenser there should be an open type, in preference to the closed type, feed water heater. This, because the open type heater acts as a reboiler and the air is purged at the vent, thus relieving the vacuum pump, while with the closed type of heater the air in the water is bound to go into the boiler and on through the condenser.

The power required by the jet and barometric condensers is a great deal more than with surface condensers, partly as mentioned above due to larger amounts of air to be handled, but, primarily, due to the greater head to which the circulating water will have to be pumped. This is especially aggravated with low level jet condensers with which the benefit derived from the tail pipe is eliminated and the pump has a suction head equal to the vacuum plus the discharge head.

On the other hand, low level jet and barometric condensers are a great deal cheaper than the surface type, which is especially the case now, due to the high price of copper. In fact, these recently have not been obtainable, due to Government restrictions, except in the industries where absolutely needed. This order was issued because they were badly required for the ocean going ships built at such a rapid rate by the U. S. Shipping Board.

At times, surface condensers with iron tubes were tried with which a heat conductivity of about one-third that of copper tube condensers was obtained, but which could be overcome by making the condenser larger. The main objection to iron tube condensers is corrosion, but not as much external as internal corrosion. They, nevertheless, can be made successful, provided intelligence is used in original design.

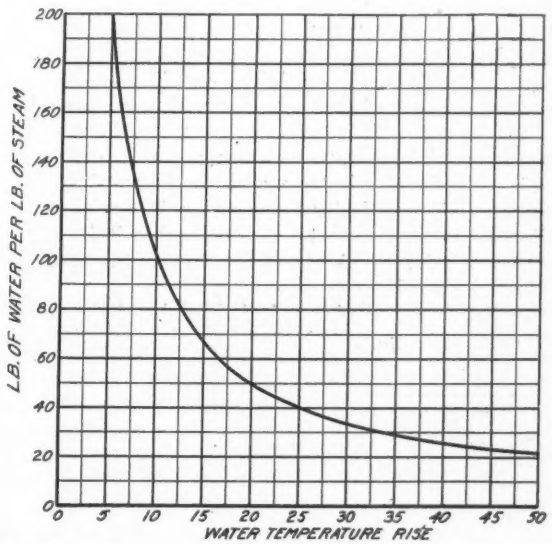


FIG. 4. TEMPERATURE RISE OF COOLING WATER WITH VARIOUS AMOUNTS

Very often the condenser is blamed for poor performance when it is not the condenser's fault. If the temperature of water is not right, naturally we cannot get the vacuum expected. This leads us to the cooling system where heat given to the water is extracted.

Cooling System

When a cooling system is used, there is one of the following kind: Forced draft cooling tower, natural draft cooling tower, atmospheric cooling tower and spray systems.

Forced draft cooling towers when well proportioned are very good; in fact, they are the most dependable. The only objection is the power required for the fans.

Natural draft tower, also, is dependable, but with the additional advantage that no fan power is required,

the air flow being produced by the temperature difference in and out of the tower, the same as in a boiler stack, only to a lesser degree. With fan towers, the amount of air handled would be more constant, while with natural draft the warmer the external air the less will be the draft and consequently air circulated.

A good type of tower to consider is a combination fan and natural draft, in which case a fan is used under adverse atmospheric conditions.

The atmospheric cooling tower has open sides and is the cheapest construction of all three. If properly proportioned, very good results are obtained; but its performance is not very dependable,* due to its dependency upon the wind velocity. When used, it should be located high on some building where there is no wind obstruction and where vapor is carried away with facility.

The last system, or spray system, is, under proper conditions, considered the best by the writer. This is especially so with a steam condenser installation. Spray systems require only low pumping heads and no fan power, but there is considerable space required for their proper installation. The original cost is relatively low and for the up-keep hardly any expenditures are needed.

The cooling of water will depend upon the wet bulb temperature, initial water temperature and surface exposed. The limit of water cooling is the wet bulb temperature and, practically, with ammonia condenser installations there should be an approach within 3 deg. of the wet bulb. With steam condensers, the approach need not be nearly so great.

Cooling tower efficiency is judged by the approach to wet bulb as expressed by the following equation:

$$\frac{T_1 - T_2}{T_1 - T} = \text{efficiency.}$$

T = wet bulb temperature.

T_1 = temperature of water before cooling.

T_2 = temperature of water after cooling.

Cooling tower efficiencies will range from 30 to 90 per cent in some cases and this should be checked frequently.

A further way of checking tower performance is by checking approach in temperature of saturated air leaving tower to temperature of water entering tower. The water distribution can be checked by taking air temperatures of air leaving the tower filling in the uppermost horizontal section of the tower. With these two tests, the writer discovered towers that were giving only one-half their intended efficiency, and when condenser was blamed, it actually was the fault of the cooling system.

A good condenser installation should be well equipped with indicating instruments so as to enable, at all times, the engineer to know what is going on, and the writer would consider the following as necessary: Thermometers for entering and leaving water temperatures; atmospheric thermometer; wet bulb thermometer; thermometer in condensate line; thermometer and accurate vacuum gage in condenser shell, and when an air cooler is used, a thermometer in the air line leading to vacuum pump.

In addition to various temperatures and pressures, it is also important to know the volumes of water and weight of steam circulated. Water can be measured quite accurately by means of a weir, which any engineer can install, on the top of the cooling tower before water is distributed. This weir whose cost, if home-made, is very small, will give him all the information needed as far as water flow is concerned.

As to steam measurement, the problem is more complicated; but if turbines are used, the steadiness of flow enables the use of any of the good types of flow meters, but with reciprocating machinery, due to the pulsations, they become entirely valueless, in which case only a positive meter can be considered for measuring the condensate after it leaves the condenser.

Notes on Lignite*

ITS CHARACTERISTICS AND UTILIZATION. BY S. M. DARLING

THIS short summary of present information on the composition and utilization of lignite is issued by the Bureau of Mines for the purpose of outlining problems that are of immediate and urgent importance to the maintenance of industrial activity and the upholding of the utmost efficiency in the conduct of the war.

CLASSIFICATION OF COALS

WHEN ranked according to value, the coals in the United States fall into three groups:

1. Anthracite, semi-anthracite, semi-bituminous and bituminous coals.
2. Sub-bituminous coals.
3. Lignite.

This classification rests partly on the percentages of volatile matter, oxygen and moisture contained in the coals. There is, speaking generally, a progressive loss of these elements in passing from lignite to anthracite. But chemical criteria alone are not a sufficient basis for such classification. The dividing line is really determined by physical characteristics that directly affect the market value of the coals.

Although sub-bituminous coals generally have more moisture than bituminous coals, there are so many exceptions to this rule that it has little value as a means of distinction. But there is a very marked difference in behavior on weathering: The sub-bituminous coals on exposure, give up their moisture more readily; as a result they shrink, crack irregularly, and in a measure disintegrate; whereas the bituminous coals shrink very little and show practically no disintegration on drying.

Again, between sub-bituminous coal and lignite there is no clearly defined chemical difference; but the physical difference is marked: The sub-bituminous coal is black and shiny, has little trace of woody structure, carries less moisture and has a greater heating value than lignite, and is capable of producing a coke of fairly good quality. Lignite, on the other hand, is brown,

* Abstract of Technical Paper 178, from the Bureau of Mines.

dull, markedly woody in texture, has no coking quality whatever, carries a greater percentage of moisture, which it gives up readily, and its disintegration on exposure is so rapid as largely to prevent its shipment any distance, except during the excessively cold northern winters, when it is, of course, frozen.

The nation's coal resources of all ranks total 3,553,637,100,000 minable tons. Of this total, 1,051,290,000,000 tons or nearly one-third, is lignite. Of this lignite, 964,424,000,000 tons are in North and South Dakota and northeastern Montana; in Texas approximately 23,000,000,000 tons; in Alaska, 7,404,300,000 tons, and relatively smaller quantities in several of the other western and southern states. (U. S. Geological Survey, Professional Paper 100).

The lignite tonnage given above includes only group 3; it does not include group 2, sub-bituminous coal, which in earlier days was called "black lignite" and classed in the lowest rank among coals—lignite.

Characteristics of Lignite

It is an important economic consideration that these lignites are found in those parts of the country that have no other solid fuel. They compare substantially as follows:

Average Proximate Analyses of Lignite.

	Arkansas.	Texas.	North Dakota.
Moisture	29.73	28.63	27.13
Volatile hydrocarbons	37.87	32.53	29.11
Fixed carbon	23.95	30.43	36.16
Ash	9.45	8.41	7.60

The Alaska lignite closely resembles that of Texas and North Dakota.

The sulphur content of the lignite in these fields rarely exceeds one per cent. The average heating value is about 7500 B.t.u. per pound.

The feature that distinguishes the Arkansas lignite from the others is the high percentage of volatile matter, which yields large quantities of oils and tars.

The large percentage of moisture in lignite has not been absorbed from extraneous sources, but is the portion, partly chemically combined, remaining from the great amount of water present in the peat from which the lignite was derived. This water is poor stuff to pay freight on or put into a furnace; further, its partial evaporation in warm weather causes rapid disintegration or "slacking," reducing the practical shipping radius during warm weather almost to zero. Lignite fires quickly from spontaneous combustion, making safe storage in even small quantities exceedingly difficult. It does not "coke," in the sense that bituminous coal cokes, but rather crumbles, when being carbonized or when thrown onto the fire, and this gives rise to difficulties in firing and substantial loss, as unburned fuel, through the grate bars.

Fuel Needs of Lignite Areas

For these reasons lignite is not a desirable fuel as mined, and millions of tons of bituminous and anthracite coals are shipped annually into the lignite-bearing regions—literally "carrying coals to Newcastle"—resulting in high prices for both industrial and domestic fuel, imposing a great handicap on the industrial development of these regions, tying up much transportation equipment now urgently needed for other service, and causing other economic lost motion.

Thus the economic problem is not local but *national.*

The territory naturally tributary to the Dakota lignite deposits embraces North Dakota, South Dakota and western Minnesota. Upwards of 2,000,000 tons of bituminous coal are shipped annually into that territory from Illinois, Indiana, West Virginia, Kentucky and Pennsylvania. The average haul of coal is 1000 mi. If the Dakota lignite were put into stable and serviceable condition, by means of carbonizing and briquetting, this fuel demand could be supplied with an average haul of less than 400 mi. The average freight rate is about 4 mills per ton mile. Therefore if the fuel and power requirements of this section were supplied from the Dakota lignite mines an annual saving would be effected of $4,800,000 in freight charges alone. Such utilization would also save annually the travel of 50,000 cars and 1200 engines and crews a distance of 600 mi.

The economic waste involved in this almost transcontinental shipment of coal is little short of criminal.

All of the coal imported into North and South Dakota and a substantial part of that consumed by Minnesota can and should be replaced by lignite from the Dakota fields, if the lignite is properly prepared, by means of drying or carbonizing or briquetting, or such combinations of these processes as the market demands.

Wastes in Present Methods of Burning Coal

The practice of burning high volatile coals on ordinary furnace grates is wasteful.

Our leading engineers and chemists have for many years decried the waste of burning raw bituminous coal. They have time and again shown that it is far more economical to break the coal up, by means of carbonization, into its constituent elements of solid carbon, gas, ammonia, oils and tars, thus releasing these several valuable products for use in their respective fields.

The fixed carbon is easy to burn because it stays on the grate. The tars and the more complex gases distilled and rising from the fuel bed are quickly decomposed into soot and simple gases, and the soot in large measure passes out of the stack as black smoke, adding the element of nuisance to that of waste. Heat in the form of coal gas brings eight to sixteen times the price of an equivalent amount of heat in the form of coal. Benzol, toluol and other oils are obtained as a result of this process of carbonization, and the value of heat in this form of motor fuel is twenty to thirty times as great as that of heat in the form of coal. (U. S. Bureau of Mines Bulletin 135.)

Further, the cheapest method of obtaining nitrogen products for explosives or fertilizers is to procure them from the ammoniacal liquor and gas resulting from the carbonization of coal or its gasification in by-product gas producers.

It is undeniable that in the future the principal use of high volatile coals will be in the by-product gas plants because of the higher commercial value of the products of carbonization. It is even suggested that "the time may come when our views of the relative values of the different coals will change and we shall consider anthra-

cite as of minor importance as compared with the high volatile bituminous coals." (U. S. Bureau of Mines Bulletin 135.)

In Bulletin 102, part 4, of the Smithsonian Institution, there appears the following suggestion:

"It is not beyond the bounds of reason to foresee a condition whereby a householder, in the place of his ton of anthracite which he now welcomes for $11, will receive a ton of smokeless coal without slate, a month's supply of cooking gas, 40 mi. of motor fuel, enough fertilizer to start a small garden, and tar sufficient to allay the dust in front of his house—all for far less money than he now pays for inferior coal."

This picture is not a fanciful one; our high volatile coals and lignites contain precisely these possibilities within themselves.

Because of the inherent shortcomings as fuel in the raw lignite itself, one can safely say that it will never be used to any great extent in its raw state. The one fact of its containing 30 per cent of water would of itself prevent use elsewhere than in the immediate vicinity of the mine. This treatment, or carbonization, of the lignite, therefore, which is absolutely essential to its more general use, is strictly in accordance with modern scientific research. We are simply, from necessity, starting to do with lignite now what will eventually be done with all of our high volatile coals.

Efficient Utilization of Lignite

Some progress has been made in the way of better utilization of lignite. Instructive experiments have been made by the United States Bureau of Mines, the State of North Dakota and the Province of Saskatchewan, Canada, which bring the matter measurably nearer to a satisfactory solution.

Instead of trying to burn the raw lignite in the primitive and wasteful ways now employed, it should be modified to produce several products, each peculiarly adapted to a particular commercial need, namely:

1. Dried lignite, for use on automatic stokers and in fuel-gas producers. Because of its more or less soft and comminuted condition the dried lignite cannot be handled advantageously by hand, but it can be used very satisfactorily by mechanical means.

2. Powdered fuel, from the dried, pulverized lignite, for use in cement kilns, railroad locomotives and other larger furnaces. Because of its high volatile content this pulverized lignite makes an exceptionally good powdered fuel.

3. Dried lignite briquets, for large hand-fired industrial furnaces and heating plants. Where it is necessary to handle the dried lignite with a fireman's shovel it should be briquetted. Tests of these dried lignite briquets in commercial boiler furnaces have proved them to be equal to good Middle West bituminous coal.

4. Carbonized lignite, for use in suction power-gas producers. Tests of this product in carload lots have proved it to be an exceptional and unexcelled fuel for this purpose. Its chemical composition, as shown by analysis, is about the same as that of Pennsylvania anthracite. In carbonizing the lignite the objectionable tar found in all coals containing a substantial quantity of volatile matter is removed, and the gas goes to the cylinder of the gas engine clean and tar free. For the production of power in this way carbonized lignite is fully equal to anthracite coal, charcoal or bituminous coke, the standard fuels for such purpose.

This carbonized lignite can also be burned satisfactorily on the automatic stokers and grates used to consume the smaller sizes of anthracite.

5. Carbonized lignite briquets, for domestic service in house heating stoves and furnaces, fireplaces and cooking ranges. This fuel, ton for ton, compares favorably with anthracite coal, and is an ideal domestic fuel in such rigorous climates as those of North Dakota and Alaska. In climates where the thermometer not infrequently goes to 40 below zero this demand is immediate and very large.

6. Sulphate of ammonia and producer gas: The raw lignite, just as it is mined, when used in by-product gas producers of the Mond type, makes sulphate of ammonia, producer gas and some tars of undetermined value; there is no solid residue except ash. Lignite carries on the average about 1.40 per cent of nitrogen. If this nitrogen were wholly recovered as sulphate of ammonia the yield would be about 147 lb. per ton of lignite. This theoretical yield, of course, could not be obtained in commercial practice; the actual yield of sulphate of ammonia per ton of lignite gasified would be 70 to 80 lb. The gas yield per ton of lignite would be 60,000 to 70,000 cu. ft. of about 140 B.t.u. per cu. ft. This gas could be used as a furnace fuel or in a gas engine to produce power. If the latter, it would yield 700 to 800 hp.-hr. per ton of lignite gasified.

The fact that the lignite does not coke in the sense that bituminous coal cokes, but rather crumbles, on being carbonized, makes possible a continuous and comparatively inexpensive distilling process, thus obviating the laborious and expensive charging and drawing of retorts as practiced in coal gas plants. It also parts with its volatile content more readily than does bituminous coal. The entire process is mechanical. The fuel need not be handled by manual labor from the time the lignite is loaded into the mine car until the briquets are en route to the consumer. The costly element of labor is reduced practically to that required for directing mechanical operations.

U. S. Civil Service Commission announces an examination for aid to fill vacancies occurring in the positions of deck officer and extra observer in the Coast and Geodetic Survey. Competitors will not be required to report for examination at any place, but will be rated on surveying and astronomy, mathematics (including mechanics), physics, nontechnical subjects, training and experience. Completion of the junior year in good standing in the civil engineering course of a college, university or technical school of recognized standing, is a prerequisite for consideration. Applicants must have reached their twentieth but not their twenty-fifth birthday on the date of making oath to the application. The income of a deck officer or extra observer from salary and allowance is somewhat over $1300 a year. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Learning is to the studious and riches to the careful.

Measurement of Stack Heat Losses

ELECTRICAL DEVICE EMBODYING SIMPLICITY AND ACCURACY ENABLES THEIR READY DETERMINATION. BY J. H. BLAKEY

THE following description of an apparatus devised by Marcel Chopin, for the registration of heat losses in the chimney of a boiler installation, was presented to the French Academy of Sciences by M. H. Le Chatelier on July 29.

The loss of heat at the chimney constitutes in general the most important cause of a diminution in the efficiency of heating plants. The appliance here described is for the purpose of giving at the same time the temperature of the furnace gases at the base of the chimney the amount of carbon dioxide in these gases and the resulting loss of heat.

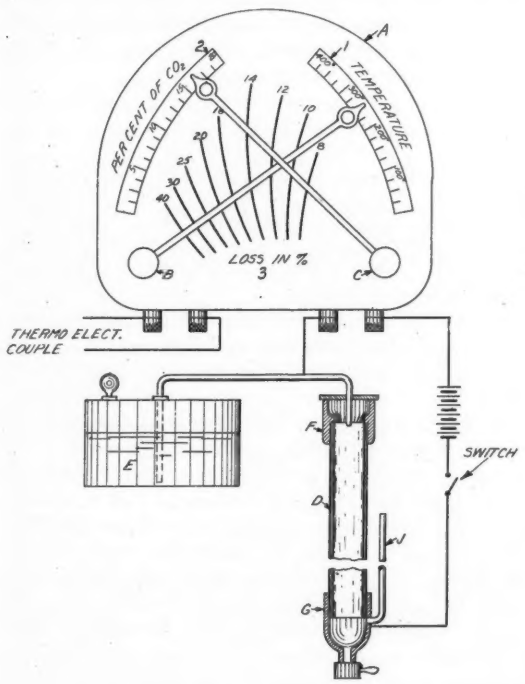


FIG. 1. DIAGRAM OF CHOPIN APPARATUS FOR SHOWING HEAT LOSSES AT BASE OF CHIMNEY

It is known that if we represent by P the heat loss at the chimney in percentage of the heating power of the fuel, by T_1 and T_2 the respective temperatures of the air entering the furnace and of the smoke or gases leaving the boiler, and by A the amount of CO_2 contained in these gases, then these quantities are connected by the equation

$$P = K\frac{(T_2 - T_1)}{A}$$

in which K is a proportional coefficient. This formula is practically applicable to the combustion of coal in an excess of air.

In the apparatus here described the temperature and the amount of carbon dioxide are represented by two electric currents, the intensities of which depend upon these variables, and the loss of heat at the chimney is obtained by arriving at the quotient of these two currents, according to the formula given.

The electrical representation of the amount of carbonic acid is produced in the following way:

When a constant volume of the gas to be analyzed is mixed with a constant volume of caustic soda (NaOH), there is produced a mixture of soda and carbonate of soda, in which the relative proportions depend upon the amount of CO_2 in the gas. Further, the specific resistance of this solution of carbonate of soda is about three times as great as the resistance of the solution from which it comes. It is sufficient, therefore, to compare the electrical resistance of the solution before and after the passage of the furnace gases through it,

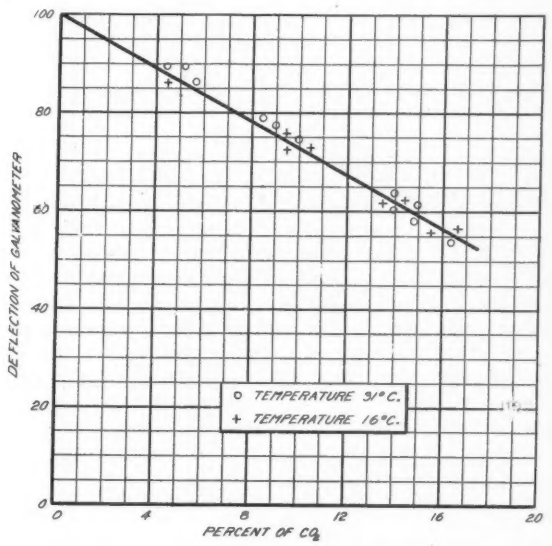


FIG. 2. RESULTS OF TEST OF THE CHOPIN APPARATUS

to get a measure of the amount of CO_2 present. This method is evidently applicable also to other analytical determinations, where the reagent employed undergoes a sensible change of electrical resistance as the result of the absorption of the element analyzed.

Figure 1 represents in diagram one of the appliances. A is a dial on which are mounted the needle of a thermoelectric couple B, and the needle of an amperemeter C; giving on one side the temperature values and on the other the percentages of CO_2. The quotient of the two currents is given by a curve which is the focus of the point of intersection of the two needles, which are the curves of equal loss at the chimney. Tube D serves first as a measure of constant volume for the titrated solution of soda drawn from tank E; secondly, for the mixture in this solution of a constant volume of furnace gas brought by tube J, and, in the third place, to form a column of resistance of the solution contained between the two nickel electrodes F and G, which are a part of the electric circuit. Before taking

measurements, the circuit is closed on a column of caustic soda, and the needle C is brought to zero on the CO_2 scale by means of a variable magnetic shunt provided for this purpose. After the absorption of the gases the circuit is closed and the movement of the needle C gives the measure of the amount of CO_2. The strength of the current at the electrodes must be sufficient to render constant the influence of electrolytic polarization.

Figure 2 is a chart representing some of the tests made with the apparatus; the abscissae give the amount of CO_2 in the gases, measured by means of a Bunte azotometer; on the ordinates are the numbers indicating the deviations of the amperemeter needle. The reagent contained 100 grams of caustic soda per liter of distilled water; the resistance column was 8.5 mm. in diameter and 110 mm. long; the volume of gas was 1950 cu. cent., flowing in 170 sec.; the source of the current was a battery of six dry cells connected in series. It can be seen that the exactitude obtained was sufficient for all industrial purposes, and the simplicity of the method of operation renders the apparatus easily used even by an attendant without any special training.

Auxiliary Plant Costs in Water-Power Service

A DECISION of much interest to the power plant economist was recently handed down by the Massachusetts Gas and Electric Light Commission. The commission investigated the rates charged the town of Westfield by the Turners Falls Power & Electric Co. and found them reasonable. These rates vary according to the price of coal at the electric company's steam plant in Chicopee, running with $8 coal from 1.2 to 1.5 cents per kilowatt-hour, depending upon the amount of energy taken; that is, a coal clause in the contract establishes a rate differential reflecting the price of fuel.

The commission pointed out that electric rates on a hydro-steam system properly include the cost of supplying auxiliary plant service. Such auxiliary service may be furnished in large volume one year and in small quantities the next, but the standby and running charges on the steam installation must be carried by the power purchaser, as well as the actual cost of production, including a fair profit on the energy sold. The price of service must be high enough to cover these various costs. The cost of supplying auxiliary power by steam when the water wheels are unable to meet the load requirements is a proper component of the integrated rate.

In many places, hydroelectric power rates are conspicuously low in comparison with steam plant rates, but the advent of the large steam turbine has reduced the cost of energy production from coal to a point where it can compete in large outputs from tide-water stations with very cheap hydro-service. There is no standard cost of power, whether generated by steam or by falling water. In fixing the rate, therefore, on a system using both water-driven and steam-driven generators, it is essential to determine the costs of different and combined outputs from both classes of prime movers. The cost of production in independent plants in the same locality cannot be exceeded if the sale of energy to them is to be a commercial success; or, in other words, the competition of other sources sets an upper limit on what can be charged for particular supplies.

The layman might suppose that the cost of auxiliary steam power would be but a small factor in the rate on a system like that of the Turners Falls company. The growth of the company's load in the Connecticut Valley has been so rapid that it has been necessary to build a steam plant of 30,000-kw. initial rating to suplement the existing hydroelectric stations. Roughly, for every 4 or 5 kw. of hydroelectric capacity the company has now provided 3 kw. in auxiliary steam plant equipment, and at no distant time it is likely that the steam auxiliary capacity of the system will exceed the water power units. The days of single plant type systems covering large areas appear to be passing, as does the sequestration of central stations within extremely limited markets. Interconnection is bringing about a peaceful revolution in energy production and distribution, and it is important in dealing with costs and prices not to overlook relationships and changing proportions of cost elements which exert a profound if indirect effect upon the price at which a given service can be rendered.

Coal in 1918

DURING the greater part of 1918, coal production was at a higher rate than for 1917. January showed a decrease, due to the severe weather, and November and December showed heavy falling off, with a bad slump during the last week of 1918 to the lowest weekly production in 3 yr.

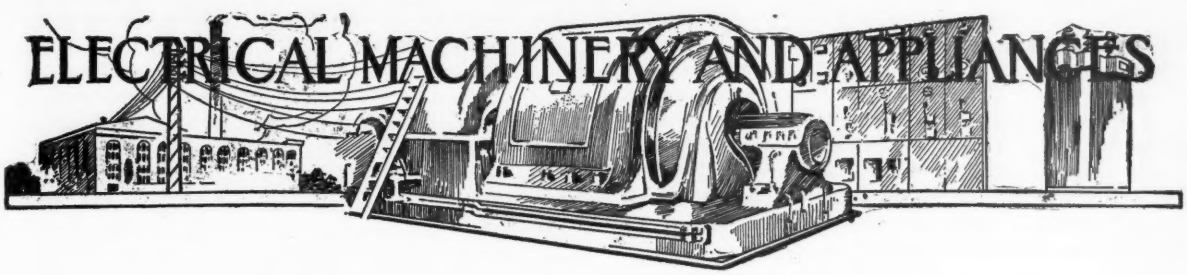
For the entire year, 1918 showed an increase of 34,000,000 T. of bituminous coal and lignite over 1917, but for anthracite, 1,606,000 T. less was mined in 1918 than in 1917.

The warm weather in November and December, and stopping of war activities resulted in an ample supply on hand, so that there is now no danger of a coal shortage, although the supply of anthracite will probably be short of the demand in some sections of the country.

The largest increases in production were in Utah, Ohio, Wyoming and Tennessee, their gains being 34, 14, 12 and 12 per cent respectively. Pennsylvania, West Virginia, Oklahoma, New Mexico, Kentucky, Illinois and Alabama gained from 6 to 9 per cent, and most other states made some gain; but Georgia, Iowa, Missouri and Texas fell below their 1917 production.

Gain in economical use of coal in coke making is indicated by the increase of by-product coke from 40 per cent of the total in 1917 to 46 per cent in 1918, the largest gains being in Indiana, Minnesota, Ohio and Pennsylvania, although in percentage Washington, West Virginia and Tennessee made big showings. It is to be hoped and expected that 1919 will definitely place by-product coke in the supremacy over that from the wasteful bee-hive method.

THE FUNDAMENTAL method of reaching each foreign-born person with the message of America, is not by holding them up on street corners and public places, but in the course of our natural relationships during the day's living. We ask ourselves where Americanization can take place most genuinely and most readily: the home, the shop, the school, the church, the fraternal organization and the court.



Characteristics of Electric Motors---I

A Discussion of Properties and Performances of Various Types of Machines to Render Possible Selection of Motor Best Suited to Meet Requirements of Service

GENERALLY SPEAKING, electric motors may be classified as alternating-current and direct-current machines. And while, as a rule, the type of machine installed is dependent upon the kind of service available, there are many instances where more satisfactory results, better performance and a higher degree of overall economy may be secured by using only a motor the characteristics of which best adapt it for the work to be done. This is particularly true in the case of delicate, intricate and expensive manufacturing processes, in which shutdown or even improper performance may result in not only spoilage but actual damage to the finished product, involving perhaps thousands of dollars of loss.

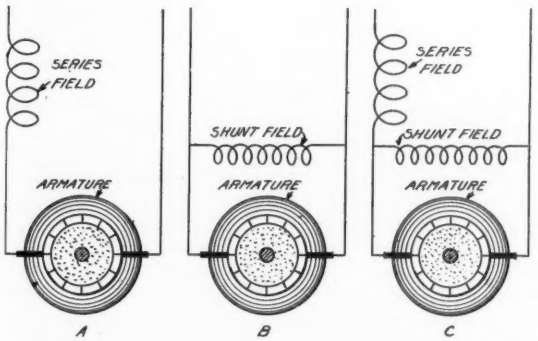


FIG. 1. ELEMENTARY DIAGRAMS OF CONNECTIONS OF SERIES, SHUNT AND COMPOUND MOTOR

Due to the later development of alternating-current motors, all of the early machines were of the direct-current type, which, according to the style of winding employed, are generally classified as series, shunt and compound, with a further modification of the latter as straight, cumulative and differential.

Elementary winding diagrams of series, shunt and compound wound machines are shown at A, B and C, respectively, in Fig. 1.

The characteristics of a series wound motor are shown in Fig. 2, and, as will be noted, this type of machine has a torque curve which varies inversely as the speed, thus making this motor particularly applicable where the factor of speed is of minor importance, but where a high starting torque is desirable. As a result, the series motor finds its greatest utility in the fields of electric traction, fan, crane or other work not requiring constant speed, but at all times insuring a constant load without which the motor would tend to run away, with the consequence of damage to not only the motor but also, in many cases, to the driven machine or machines.

The speed of such a motor is ordinarily varied by shunting the field, shunting the armature or, as in the case of electric railway work, by inserting an adjustable resistance in series with field and armature windings. With the latter method, for a given load the

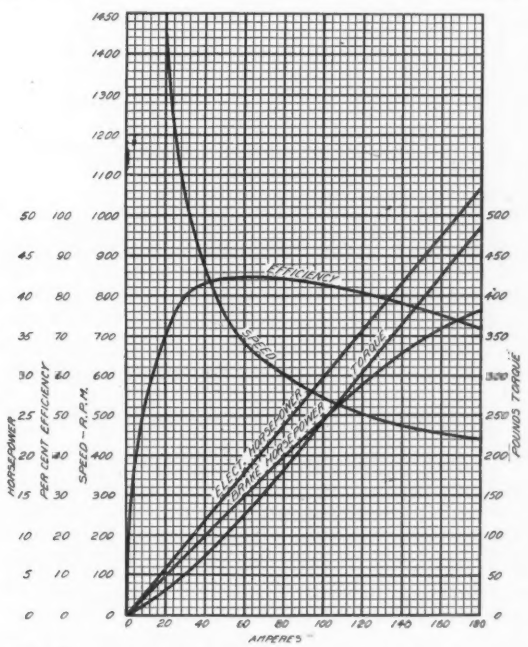


FIG. 2. CHARACTERISTICS OF A SERIES-WOUND MOTOR

motor draws the same current, regardless of speed, and the speed varies with the applied voltage.

After a series motor has been brought up to its normal speed by means of some form of starting rheostat, increase in speed at a given load may then be realized by inserting a resistance across or in shunt with the field, this action being due to the reduction in current flow through the field winding with accompanying decrease of field strength. On the other hand, assuming that all of the starting resistance has been cut out of circuit, connecting a resistance in parallel with the armature will result in a reduction of speed,

an arrangement especially useful where low speed is desired at light loads.

Shunt-Wound Motors

A machine well adapted to practically all forms of constant speed work is the shunt-wound, direct-current motor, characteristics of which are shown in Fig. 3. Torque in this type of motor increases almost directly with the current, while the speed from no load to full load decreases but very slightly, regulation in practice varying from about 3 to 7 per cent.

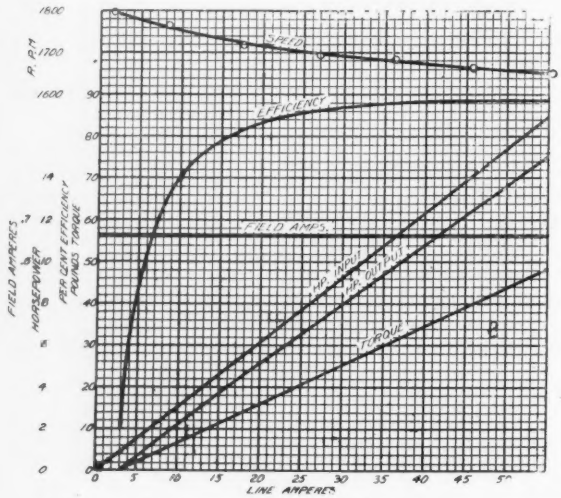


FIG. 3. CHARACTERISTICS OF A 230-V., 10-HP. SHUNT-WOUND MOTOR

Due to the constant flow of current through the field windings, it would appear as if the speed should remain absolutely constant; but, due to two factors, this is not true. With the flow of current maintained, the windings heat and, as a result, increase in resistance, thus bringing about a reduced field strength and as a consequence a rise in speed. This action is, however,

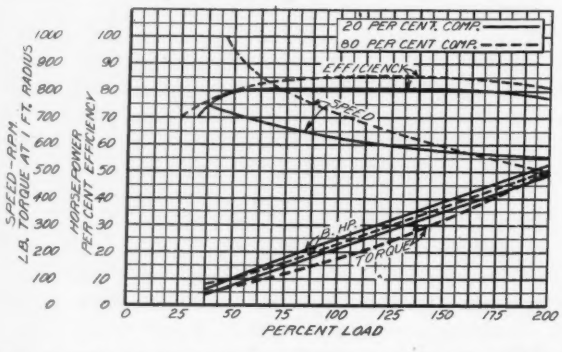


FIG. 4. CHARACTERISTICS OF A TYPICAL COMPOUND-WOUND MOTOR ARRANGED FOR 20 AND 80 PER CENT COMPOUNDING

more than offset by the voltage drop in the armature, with increase of load, which, as stated, produces a slight drop in speed.

Shunt motors are not very susceptible to drop in speed due to line voltage drop, the per cent of speed change being considerably less than that of voltage change. Actually, the former is from 0.6 to 0.8 of the latter, so that with a 10 per cent drop in line voltage a drop of from but 6 to 8 per cent of speed may be expected.

As the name implies, the shunt-wound motor has its field connected directly across the brush terminals, and as a consequence a constant current flows through the field, with the result that the field losses and stray power losses remain practically constant. Due, therefore, to these constant losses, at low loads the efficiency of such a machine is comparatively low. With increasing load, however, the field and stray power losses become relatively small, bringing about an increase of efficiency to approximately the rated capacity of the machine beyond which, on account of the rapid increase in armature loss, the efficiency curve tends to decline.

Efficiencies of shunt motors are also greatly dependent upon size, a machine of about ¼ hp. having a maximum efficiency of perhaps no more than 60 per cent, while machines of 30 hp. and larger may have efficiencies of 90 per cent and more.

Compound-Wound Motors

As motors of this type employ both series and shunt windings they partake of the characteristics of both

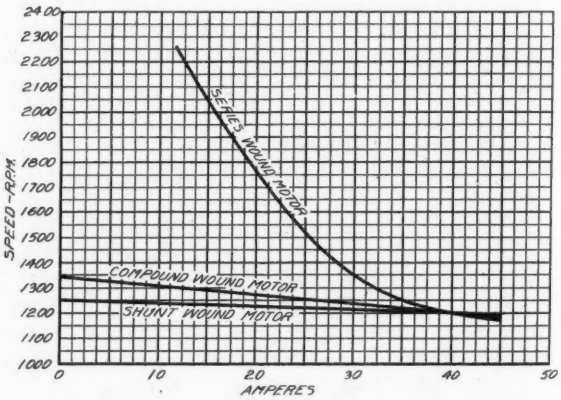


FIG. 5. SPEED-LOAD CHARACTERISTICS OF 10-HP. SERIES, SHUNT AND COMPOUND WOUND MOTORS

series and shunt wound machines. Characteristic curves of a typical compound-wound motor are shown in Fig. 4, and, as will be noted, the speed, due to the combined action of the two fields, does not fall as abruptly with increase of load as in the case of the series motor, and still is not quite as constant as in the case of the shunt-wound motor. Figure 5 illustrates the speed-load characteristics of 10-hp. series, shunt and compound-wound motors.

Speed and torque characteristics of a compound-wound motor are determined by the relative influences of the series and shunt fields, so that by varying these factors in any ratio desired, speed and torque characteristics may be made to approach those of the series-wound motor with just sufficient shunt field effect to prevent running away of the motor at light loads. In a similar manner they may be made to approach the constant speed characteristics of the shunt machine.

By connecting the series coil in such manner as will cause the current to flow in the same direction as that

in the shunt winding, the field strength increases with increase of load, thus providing a comparatively heavy starting torque combined with a speed similar to that of the shunt motor.

Frequently arrangements are made whereby on starting the series coil is in circuit, but cut out when the motor has obtained full speed. This type of motor, generally referred to as the cumulative compound wound, is particularly adapted where the motor is frequently started and stopped under heavy load and where practically constant speed is desired.

In the differential compound-wound motor the direction of current flow through series and shunt windings is in opposite directions, thus decreasing the resultant field strength and consequently increasing the speed with increase of load.

The speed of shunt-wound motors, as has been pointed out, decreases slightly with increase of load, so that if a series winding of sufficient strength be applied in a manner such as to give a differential effect, it is possible to eliminate this slight drop and secure a constant speed throughout the rated capacity of the motor.

The most serious disadvantage possessed by a differential compound-wound machine is that with a large overload owing to the excessive current in the field coils, the fields tend to, or may become, demagnetized, and instead of the motor maintaining its speed, it may slow down or stop, and as a result possibly burn out.

The efficiency curve of a compound-wound motor rises quite rapidly with increasing load, reaches a maximum at a load somewhat less than the rated capacity of the machine, and then gradually declines.

(To be continued.)

Shaft and Bearing Currents

Methods of Determination and Elimination.

By F. Ashton

IT IS a well-known fact that under certain conditions local currents may be set up in the shafts and bearings of electrical machinery. These currents may cause pitting of the bearing linings, and if the currents are sufficiently heavy the journals may suffer as well. If the magnetic circuits of a machine are not completely symmetrical, or if there is a difference in the permeability of the material of which the magnetic circuits are composed, then a voltage may be generated in the shaft and will send a current through the bearings, the bearing pedestals and bedplate. Badly machined joints are frequently responsible for the trouble. Tests have shown that so long as the current density is below one ampere per square inch of contact, the damage is confined to the bearing linings; but if this value is exceeded, then damage is usually done to the shaft. Bearing currents may be set up in all classes of electrical machinery, and when they are found to exist, steps should be taken to eliminate them. Alternating-current machines (large induction motors, for instance) are rather more apt to come to grief as the result of bearing currents than other machines, because when the stator windings are energized an electromotive force may be set up in the shaft as the result of electro-magnetic induction, even if the resistance of the rotor circuit is high or the rotor windings are completely open-circuited. These currents may be considerably higher than the current which passes through the shaft and bearings when the machine is running, owing to the low resistance between the bearings and journals.

The most obvious way of discovering whether the shaft of an electrical machine is carrying a current is to connect an ammeter between the shaft and the foot of one of the bearing pedestals as shown in Fig. 1. One lead of the ammeter is connected to a brush rubbing on the shaft, while the other lead is clamped under one of the pedestal bolts. The resistance of the ammeter circuit should be as low as possible, and a wire-gauze brush should be used. When the machine is fully excited and running at its normal speed, an ammeter connected in this manner may or may not indicate the presence of a bearing current. Obviously the ammeter circuit forms a shunt to the shaft and bearing circuit, and the resistance of the former circuit may be too high to induce a measurable current to flow through it. If the instrument does not show a reading, a low-reading ammeter (say, suitable for a maximum current of 5 or 10 amp.) might be tried, and if it is still found impossible to get a reading it is safe to conclude that the bearing current is either small or non-existent.

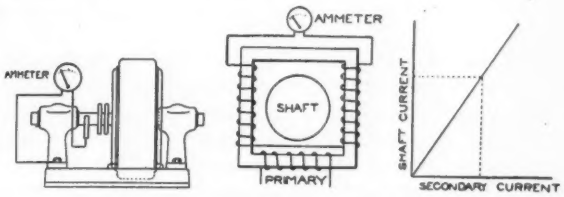


FIG. 1. METHOD OF CONNECTING AMMETER TO DETERMINE PRESENCE OF SHAFT AND BEARING CURRENTS

FIG. 2. SCHEME OF CONNECTIONS USED FOR ALTERNATING-CURRENT MACHINE

FIG. 3. SHAFT AND BEARING CURRENTS CURVE

In the case of alternating-current machines, however, the actual amount of current may be measured with a good degree of accuracy. A method adopted by the General Electric Co. involves the use of a current transformer with a core built up of rectangular laminated plates. The core should be provided with two separate windings, as shown in Fig. 2, the winding to which the ammeter is connected being the secondary. The ammeter should, of course, be suitable for alternating current. In circuit with the lower winding marked "primary" (having a known number of turns) another alternating-current ammeter should be connected, and this latter winding should be energized from some external current supply, having the same frequency as that for which the machine is designed. This second winding is simply for calibrating purposes, and when the shaft current is being measured, by means of the ammeter in circuit with the other winding, the calibrating or primary winding should be disconnected from the supply, the shaft of the machine then becoming the primary. The rotor should be removed from the machine and the transformer threaded over the shaft so that when the rotor is replaced the transformer is situated between the rotor and one of the bearings. By impressing various voltages upon the primary or cali-

brating coil various currents will, of course, be made to circulate in this coil, and if the number of turns on the coil is known, the exciting ampere turns can be calculated by multiplying the current by the number of turns. The exciting values so obtained should be noted, together with the corresponding current in the secondary circuit to which the ammeter shown in Fig. 2 is connected. Having obtained these values, the primary or calibrating coil should be disconnected from the source of supply, and the shaft of the machine then becomes the primary of the transformer. This primary is obviously composed of only one turn, so that the primary current and primary ampere turns are identical. If a curve be plotted between the readings obtained in the manner described (ampere turns and secondary amperes) it will be possible, if the curve assumes a straight line, to arrive at an average multiplying factor which links the primary ampere turns and secondary amperes, and this factor will, of course, be the ratio of the transformer. But when the alternator is running the shaft becomes the primary, and by noting the current in the secondary of the transformer the actual shaft current can be arrived at either by multiplying the secondary current by the transformer ratio or by reading it off directly from the curve as show in Fig. 3.

If it is found that a current is circulating in the shaft and bearings that is liable to cause damage, the question then arises as to how this current can be eliminated. Of course, there is no objection to a shaft current, provided that it is confined to the shaft and does not pass into the bearings; hence if brushes are placed at both ends of the shaft, and are either connected to the bearing pedestals or are connected together by a low-resistance copper conductor, bearing troubles will be eliminated. Another and better method of overcoming the difficulty is completely to insulate one or both of the bearing pedestals from the bedplate. This may be done by removing metal shims from under the bearing pedestals and replacing them with thin sheets of fiber. All holding-down bolts must, of course, also be insulated with fiber tubes and fiber washers.—MECHANICAL WORLD.

Governmental Operation of Public Utilities---I

CONDITIONS THAT MAKE EFFICIENCY AND ECONOMY PRATCICALLY IMPOSSIBLE; FUNDAMENTAL DEFECTS OF THE SYSTEM. BY F. B. DEBERARD

FUNDAMENTAL PRINCIPLES of our system of government are that the personnel of the legislative and the higher officials of the executive branches be subject to periodical change; that executive discretion be closely limited by law; and that no outlays of public moneys be made except expressly authorized by law. We have here the assurance of frequent changes in both directive and administrative control; the practical certainty of frequent and perhaps radical changes of policy; the impairment of executive efficiency; and the delay or withholding of necessary funds. These conditions, which are of political origin and are inescapable, make economic efficiency impossible.

REQUIREMENTS OF EFFICIENCY

ECONOMIC efficiency requires the incentive of self-interest, not only on the part of the owners of a business enterprise, but also on the part of all employes; a definite, carefully planned, and consistent policy; a perfectly co-ordinated plan of operation; prompt provision of funds needed for plant betterments and extensions; constant and intimate touch between directorate and executive; infrequent change of executive officials, tenure during efficiency, and practically unrestricted executive authority over operation. All these requisites are present in well-managed industrial corporations; most of them are usually, and some of them are always, lacking in public undertakings.

THE EXECUTIVE

ESSENTIALS of an efficient executive are:

Comprehensive experience, and thorough special training; exceptional organizing and executive ability; and intimate knowledge of detail; full accord with the directorate as to policy and a considerable degree of influence in determining policy; practically complete control over organization, personnel, operating methods, and all details; full enlistment of self-interest as an incentive.

Practically every important business corporation having to do with physical operations conforms to these requirements.

In the management of economic affairs, important questions of policy are constantly arising. Unless promptly and wisely disposed of, the business is embarrassed, hampering and wasteful conditions arise or continue, and the business becomes unprofitable. Hence, capable business boards meet at short intervals, promptly consider and dispose of the questions of policy submitted by the management, vote the funds needed to secure or maintain economic efficiency, and in general make the authorizations which the executive demonstrates are necessary to the welfare of the business.

A business board will select an executive of proved ability, a man in whose sound judgment they have confidence, will give him prompt and ample support, allow him wide discretion as to methods and means and hold him to full responsibility for results. Thus the executive is enabled promptly to do what needs to be done to make the business economically successful. His full ability, zeal and energy are enlisted to promote efficiency, prevent waste and earn profits.

INADEQUATE PROVISION FOR BETTERMENT AND MAINTENANCE

A CHARACTERISTIC defect of governmental industrial plants is their low physical efficiency. This is due to the almost invariable unwillingness of appropriating bodies to permit existing equipment to be discarded until it has become physically unserviceable; and to insufficient outlays for maintenance. A machine is no longer economical when a new and better machine will give a larger output at lesser cost; and sound business practice discards old machinery, even if in perfect phys-

ical condition, and substitutes new whenever the resultant saving in operating costs exceeds the interest charges on the additional capital investment required. This is seldom done in governmental plants, and in consequence operating and maintenance costs per unit of production are commonly excessive.

Certain small pumping engines in New York's water supply system illustrate this. The engines in question had been many years in commission and were therefore much inferior in original potential performance, to more modern types, their coal consumption and labor costs per million gallons pumped being relatively very large. In addition, through wear, their actual performance had decreased greatly. The average annual cost, during several years, of repairs to maintain these engines in usable condition, to average about one-half rated service, was about $20,000. They could have been replaced for less than $100,000, but the necessary appropriations, frequently urged, were as uniformly denied.

Several hundred municipal lighting plants, which have been installed in various parts of the United States, have failed. The causes have been various. One invariable cause, always present, has been refusal of sufficient appropriations for maintenance and betterments, whereby the plants became inefficient and excessively costly of operation.

No large industrial enterprise can long be kept economically efficient without a continuous addition to the capital investment, to provide for betterments. Private enterprise provides such new capital because it produces corresponding earning power; but public appropriating bodies can seldom be convinced that economy requires a large additional capital outlay for the partial reconstruction of a plant which was new and fully efficient ten years ago, but which is today economically obsolete. The public almost invariably considers a first large investment as final, and violent public opposition, usually assuming political form, deters legislative bodies from making the additional appropriations which efficiency and economy require.

In the present restricted field of governmental physical undertakings, sufficient betterment and maintenance outlays are a prolific cause of excessive cost and inefficient service. The harmful effects would be multiplied many fold if extended by governmental intervention into highly complex industrial fields such as railroad or telephone operation.

Administrative Inefficiency

In the conduct of large business corporations the chief executives are chosen because of their proved fitness. They are the product of evolution. They commonly begin in the lowest ranks of the service. In subordinate positions, they display more than average ability, zeal and initiative. Because of these qualities they rise above their fellows and are selected for more important positions. Their qualities develop with opportunity. Their best effort is enlisted through self-interest, for there is keen competition for advancement, large opportunity for it, and the best man wins. Rapid promotion comes to the man who proves himself best qualified to perform the service required. In his upward progress by successive steps the future high official acquires intimate knowledge of every detail of the business, of the best methods, of efficient organization, of the merits and varying capacity of his fellow workers, of discipline, of all the complex matters which an efficient executive must know and control.

Thus exceptional capacity, developed by special training and comprehensive experience, is characteristic of the principal executive officials of large industrial corporations; and they are chosen because of that qualification. They have the confidence of their directors, are given prompt and ample support, and have full control over organization, discipline, promotion, and all details of operation.

Almost invariably the selection of governmental executives is based upon considerations other than qualifications indispensable to a good business manager. The method of selection considers popularity and disregards proficiency. It accepts active intelligence as the equivalent of highly specialized training. It assumes that brilliance is synonymous with sound judgment. It assumes that a brilliant lawyer, a high-minded and intellectual idealist, a sincere and vociferous reformer, or a shrewd and able practical politician, is as capable of managing intricate business affairs as a man of long experience, intimate knowledge and highly developed skill in the especial field concerned.

We thus commonly have, at the outset, initial unfitness on the part of the business managers selected by government, in the sense of lack of the especial qualifications required for effective performance of the business function. Even men of much general ability, when injected into a vast and intricate business machine of whose methods and details they are profoundly ignorant, must flounder woefully for a considerable time and depend upon their subordinates. But in government business the principal subordinates also are usually displaced, when the chief is changed, by new and equally untried or unfit men; and until the chief can get his bearings, the machine runs by the inertia of ancient routine. In effect, we have for a time government by chief clerks.

Effect of Frequent Changes

In industrial affairs frequent changes in management tend seriously to impair the proper co-ordination of the business machine. Each new official is likely to make changes in method and in personnel. Even when wise and desirable, such changes are apt to produce temporary dislocation until operations have become adjusted to the new conditions.

Illy-considered and often harmful changes in methods and personnel are invariable accompaniments of changes in the managing officials in charge of public industrial works. Nearly every new official thinks that extensive reforms in methods and organization are necessary, and is usually right in so thinking. But he generally ignores the fact that intimate knowledge and years of experience are requisite to devise new methods which will actually promote efficiency. The result of his efforts in such case is a new pattern of patchwork and not a new and better machine.

Evils of another class result when the new executive, conscious of his at least temporary inability, seeks refuge in inaction, and is content to be a rubber stamp. In

that event the actual conduct of affairs falls to a large degree into the hands of minor officials, each of whom is intent upon enlarging the importance of his own bureau, and conducts it so far as possible with jealous disregard of the operations of other bureaus. Differing and sometimes conflicting methods, great inertia, lack of co-ordination and imperfect functioning are the consequence.

Hampering Limitations

Even executives of the highest capacity cannot be fully effective under the hampering conditions which prevail in governmental management, for the reason that they are deprived of necessary discretionary power.

A fundamental theory of our government is that executive power shall be restricted, in order that the rights and liberties of the people shall not be subverted by abuse of such power. It cannot seriously be questioned that such restriction in governmental affairs is necessary and wise, but from that very necessity proceeds the inability of government executives to act efficiently in industrial undertakings. The public welfare requires an elaborate system of check upon executive action, but the machinery of check in public affairs is always the machinery of inertia and frequently of paralysis.

While many executive requests are unreasonable and are properly denied, it is equally true that Congress continually maintains limitations upon executive discretion which make good administration impossible. It, therefore, completely reverses the methods that are necessary to business efficiency. It prescribes and regulates in minute detail the methods which shall be followed by the executive, and thereby deprives him of necessary discretion. He cannot displace a defective method by a better one by reason of the existence of a law which precludes such action upon his part. He cannot materially change the framework of the organization through which he must work, because the law has prescribed specified divisions, bureaus and sub-divisions which must continue until changed by law. He cannot materially change the personnel of his organization, but, in the main, must take what is handed to him by his predecessor.

In industrial undertakings, conditions are constantly changing and the methods of management must be quickly adapted to meet the changed conditions. It is necessary, therefore, that the executive have large discretion as to methods, personnel, choice of assistants, salaries and promotions.

(To be continued.)

Oxy-Acetylene Welding---I*

Hints for Beginners and Pointers on Power Plant Repair Jobs, Oxygen Control, Correct Flame and Use

ACETYLENE is generated by the addition of water to calcium carbide which is made from coke and lime melted in an electric furnace. When cool the product is crushed, screened to uniform size, and shipped in moisture proof cans. The size is expressed by the size of screen used; 1¼ by ⅜-in. carbide means that none will go through finer than ⅜-in. mesh and all will go through 1¼-in. mesh screen; ¼ by 1/12-in. carbide means that it will pass through a ¼-in. screen and over a 1/12-in. screen.

Calcium carbide and water produce acetylene and slaked lime.

The calcium carbide when in contact with water is divided and the carbon of the carbide joins with the hydrogen of the water and forms acetylene gas. The calcium of the carbide unites with the oxygen of the water and gives slaked lime.

In computing gas yield, 1 lb. of ¼ by 1/12-in. carbide will yield 4 cu. ft. The larger sizes yield 4½ cu. ft. per lb.

Acetylene is a gas that, used in the torch with oxygen, produces the intense heat of about 6300 deg. F. If this gas could be safely compressed and stored it would be more useful. Experience proves, however, that the gas when compressed to 30 lb. per sq. in. or over, becomes very unstable, liable to explode unless handled with extreme care. Compressing gas generates heat; this heat in presence of the unstable gas is very dangerous, therefore the gas can not be stored in ordinary tanks with safety.

Acetone for Storing Acetylene

Acetone has the property of absorbing acetylene and is spoken of often as dissolved acetylene. As acetone takes up acetylene it increases in bulk.

Suppose a cylinder filled with acetone and dissolved acetylene, under considerable pressure. We open the valve, we draw off some acetylene. The acetone shrinks in volume and the unfilled space is filled with acetylene under pressure. This free acteylene under pressure is very explosive and dangerous under shock. It is found, however, that the gas will not dissociate when finely divided. The above principle is taken advantage of by filling the storage tank with a porous material.

By experiment it is found that a mixture of asbestos, charcoal, kieselguhr and a small amount of cement to hold it together, packed in the storage tank provides a finely divided porous filling that prevents dissociation. The mixture is moistened a very little, and the tank completely filled. This is then baked in an oven for several weeks till the moisture is completely driven off. It is then exhausted of air and the desired quantity of acetone introduced. Acetylene gas is then forced into this prepared tank by a specially cooled multiple stage pump, great care being necessary because of the unstable nature of the gas when under pressure.

The acetone absorbs the gas, 1 cu. ft. of acetone absorbing 24 cu. ft. of gas for each atmosphere of pressure (1 atmosphere in round figures is 15 lb. per sq. in.)

The filling material must be so put in as to prevent any settling as the tank is handled and shipped, for if

* Abstract of Bulletin 11, Federal Board for Vocational Training.

the material settles so as to leave a void that can fill with acetylene under pressure, it is very dangerous.

The acetone is used because of its ability to absorb the gas which enables the tank to hold more rather than for safety, as the porous filling cares for the safety feature.

The rate of discharging must be well considered, for, if the gas is drawn off too rapidly it will possibly draw some of the acetone with it. To avoid this it is usual to consider the allowable rate of discharge as one-seventh of the tank capacity per hr.; for example a 225-ft. tank will supply 225÷7, which is 32 ft. per hr.

Under emergency conditions the acetylene may be drawn at two or three times this rate, but the practice is not economical and may injure the weld.

Acetone when at a low temperature will not release as much acetylene as when warm; for this reason a tank will not yield as much gas when exposed to cold weather as when at normal temperatures.

The weight of the cylinder, acetone, and acetylene gas at atmospheric pressure is usually stamped on the cylinder. To find the amount of gas in any cylinder, weigh it and subtract the weight of the tank as stamped; convert pounds of gas into cu. ft.; 14½ cu. ft. of acetylene gas weighs 1 lb.

A tank should never be exhausted below 5 to 7 lb. pressure, as some of the acetone may be drawn off which is injurious to a weld. It is sometimes stated that the acetone flame in a torch has a long blue and not a clear white cone as with acetylene, which is true if the acetone is much in excess, but the flame will be unfit to use long before this change is noticed.

Action of Acetylene Flame

An excess of acetylene produces a carbonizing or reducing flame, as the high heat produces ideal conditions for absorption of carbon.

An excess of oxygen produces an oxidizing flame which burns the metal.

A proper mixture produces a correct or so-called neutral flame, a bluish white cone, which is the burning of the two gases as mixed in the torch, about equal quantities of each.

The products of combustion, carbon monoxide and hydrogen, mix with oxygen from the air and burn as the outer envelope. The greatest temperature is found at the tip of the blue white cone, the inside of the cone being comparatively cool. The cone must never touch the work, if it does the gas will combine with the hot metal; therefore it is better to have the torch too far away than too close to the work.

The outer envelope of burning hydrogen protects the molten metal from oxidation.

Acetylene is burned with pure oxygen. The oxygen is used instead of air because air is diluted with 77 per cent of inert gas which is called nitrogen. The nitrogen carries off a large amount of heat.

The temperature of an oxy-acetylene flame is generally considered to be 6300 deg. F. Comparing this with the melting point of cast iron, 2200 deg. F.; wrought iron, 2600 deg. F.; platinum, 3250 deg. F.; heat of an electric arc, about 7800 deg. F.

This 6300 deg. F. is produced by combustion of acetylene gas and oxygen mixed, in approximately equal proportions, in the torch.

Oxygen Control

The proportion of gases is controlled by the size of the passages in the torch, indirectly by the regulators, and to some extent by the needle valves. Figure 1 shows a typical burner.

The pressure of gases depends on the design and tips used usually given by the manufacturer. The oxygen regulator is set with the left hand to about 1 lb. above the pressure called for, to allow for adjustment of the oxygen at the pressure called for, to allow for adjustment of the oxygen at the torch to compensate for fall in pressure due to continuous work.

The acetylene flame burning in the air, white in color, large in volume and limited in temperature owing to dilution by the nitrogen of the air, smoky at the end, indicates incomplete combustion or insufficient oxygen from the air. More oxygen should be added until the flame is sharply outlined.

A correct flame, sometimes called a neutral, has neither carbonizing nor oxidizing effect on the metal and will leave the metal clear and not chemically affected.

An excess of oxygen will absorb the metal with the result that oxide is produced which is very detrimental

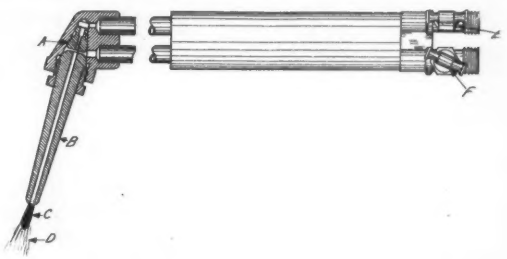


FIG. 1. TYPICAL POSITIVE PRESSURE WELDING TORCH, A. CONICAL GROUND SEAT, B. COPPER TIP, C. LUMINOUS CONE, D. SECONDARY FLAME, E. OXYGEN NEEDLE, F. ACETYLENE NEEDLE VALVE.

to the weld. Under extreme conditions the molten metal foams and has a white appearance which indicates that the metal is burned. An excess of oxygen is not as easily noticed as an excess of acetylene and for this reason it is best to watch the flame and occasionally test it by cutting down the oxygen until a shadowy outline appears beyond the cone and then increase the oxygen till this shadowy appearance just disappears, which takes only two or three seconds.

In lighting a torch, first turn on the gases up to the needle valves on the torch, holding the torch in the right hand and adjusting the regulator with the left. Adjust the oxygen pressure first then shut off the oxygen and adjust the acetylene pressure; have the appropriate needle valve on the torch fully open when adjusting the pressures. Light the acetylene jet and turn on the oxygen, adjust the oxygen needle valve to produce the proper flame. Hold the torch in the right hand, the left hand being free and the body free from any support, the tip pointing to the left making an angle of about 45 deg. with the plate, move the flame slowly back and forth across the joint a distance of about ⅛ in. on each side, at the same time advancing slowly from right to

left along the weld, holding the tip about 3/8 in. from the work, starting at the right and heating the work until a pool of molten metal is formed; carry this pool slowly across from right to left.

In preliminary practice the operator should go slow enough to blow a hole through a plate, then speed up just enough to avoid this and thus secure thorough penetration; because thorough penetration is one of the most important features of good welding.

For the beginner it is best to start in the use of adding material by welding two pieces of steel in a corner weld as shown in Fig. 2. Tack the sides of two pieces of steel together at right angles and weld from the convex side.

There is less trouble from the adding material sticking to the steel on a weld of this kind. Hold the adding material in the molten pool, and never allow the adding material to melt and drip off of the rod in drops, as the drop will have a coating of oxide and simply adhere to, rather than fuse with the metal.

Acetylene Generators

Generators are made in various sizes known as 25-lb., 50-lb., 100-lb., 200-lb., 300-lb. These numbers indicate the weight of the charge of calcium carbide to be used, the number of gallons of water per charge, and

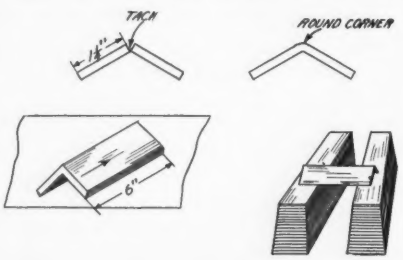


FIG. 2. FOR BEGINNERS, START WELD BY ADDING MATERIAL AS SHOWN, TACKING THE SIDES OF TWO PIECES OF MATERIAL TO BE WELDED

also the number of allowable cubic feet of gas generated per hour in accordance with the rules of the National Board of Fire Underwriters.

Generators have been made with three types of feed: 1. Carbide drops into a large body of water. 2. Water drops on the carbide. 3. Water rises slowly against the carbide.

The first is considered safer, gives cooler, cleaner gas, and keeps the pressure more uniform than the others, and is the only type at the present used for welding in the United States.

Generators are also high pressure, limited to 15 lb. per sq. in.; or low pressure, not over 1 lb. per sq. in.

There are various devices which provide for safety and insure a regular feed of carbide according to the gas used. There are also various safety valves and fool-proof devices. The pressure is set for 10 to 12 lb., with an absolute limit of 15 lb. per square inch, which has been proved to be below the danger line where the gas becomes unstable.

Charge the generator with carbide according to instructions of the manufacturer using a wooden stick to poke the carbide down.

Rid the generator of air, after charging, by generating gas to 5 lb. pressure and blowing this off through the safety valve three times before turning the gas into the lime.

As the gas leaves the generator it passes through a water-seal flash-back chamber and a felt-filled filter chamber to clean it of dirt and moisture. Experiments show that 1 gal. of water to each 1 lb. of carbide capacity of the generator will give clean, cool gas. Water should have considerable depth so as to wash the gas thoroughly.

Always have water in the generator when any action is taken that will dislodge carbide. Carbide falling on a damp surface will generate a heat that will, under certain conditions, cause an explosion. If the water has been drawn off, the generator is full of air and the bottom is damp. Air, gas, and heat are ideal conditions for an explosion.

Gas under pressure requires a reducing valve and regulator to reduce the pressure to the required point and hold it there.

Connect the regulator to the tank or supply, being careful that the coupling is tight. Do not use any grease as grease in contact with oxygen is very dangerous, particularly in the presence of heat due to sudden compression caused by opening the gas tank valve.

If any lubricant is needed, use a compound specially prepared for the purpose. In lieu of this use soap or glycerine, but use very little.

A gage is attached to show the pressure on the supply, and another gage is connected with the outlet to show the pressure on the torch. Before turning on the gas, release the spring pressure on the regulator valve. Then, by turning in on the screw, adjust the pressure till the gage on the torch side indicates the desired pressure.

The gages used should be of proper range and should read sufficiently in excess of working pressure to insure long life. On the oxygen tank, the gage should have a capacity of 3000 lb.; on the acetylene tank, 400 lb. The gage on the outlet end of the regulator will probably be 30 to 50 lb. for welding. Cutting requires a 200 or 400-lb. gage. The same gage is sometimes used for welding as well as cutting when a combination outfit is used.

Usually the high-pressure gage on the oxygen cylinder has three sets of figures. The outside set reads in pounds per square inch. The next, in cubic feet for 100-ft. cylinders; if 200-ft. cylinders are used, double the reading. The third set of figures is for 250-ft. cylinders, which, however, are rare. The readings are true only at normal temperature, 70 deg. F. Above or below this temperature, the pressure will be more or less, while the weight of gas in the cylinder has not changed.

In figuring volume of gases, the following approximate figures will be of service (volumes given are at atmospheric pressure): 100 cu. ft. oxygen weighs 9 lb., 14½ cu. ft. acetylene weighs 1 lb.

Mill-type Mazda lamps with filaments more rugged than those in ordinary types are now available in limited quantities for 110 and 220 volts, and in 25 and 50-watt sizes. These lamps are a small fraction less efficient than the regular Mazda lamps, but this is of small consequence where lamps are liable to rough use.

A Study in Colors

THE PLANT was in bad shape. The coal was bad—the steam was uncertain—frequent shutdowns were necessary. Production fell off. The men were disgruntled. Firemen were quitting on an hour's notice, and the superintendent was scouting around for new men to fill their places.

What worse conditions could you want in a plant that had previously run smoothly and had always made money? The manager sent for the "trouble shooter" and gave him full authority to locate and eliminate the "nigger in the woodpile."

The chief had taken his job on trial. He started in like a whirlwind, plugging leaks and generally making the plant a hundred per cent better than his predecessor had left it. This was all part of a plan.

As soon as he had effected enough improvement so that the results of his efforts began to attract attention in the office, he began to slack up. He had "made good" and now he was going to take a little rest in an easy berth. In recognition of his good services, the manager had fattened his pay envelope, but there was no response.

The "trouble shooter" began by getting acquainted with every man in the plant, particularly in the boiler room. The spirit of the chief had spread among the men and, as they became saturated with it, they quit. New men filled their places.

A New Candidate

IN THE course of a day or so, the superintendent remarked that another man had quit and that he had hired a colored man to fire on the watch from midnight to 8 a. m. The man had never fired before, but what are you going to do when a fireman quits on such short notice?

The trouble man stayed over that night to get a look at the new candidate and to help him over the rough spots. He weighed 109 lb.—shoes and all. If any reader has some doubt that you can develop 650 boiler horsepower on 109 lb. of "beef," just finish the story. "Beef" is hardly the word; but, whatever it was, there was only 109 lb. of it—six boiler horsepower to every pound.

He got through the night without any serious mishap. The next night he asked a few questions—the kind that show a gleam of intelligence behind them. The trouble man began to sit up and take notice. Here was a man who was asking to be shown the difference between shoveling and firing coal. He was a man who could be developed into a fireman.

Then the trouble man told him to sit down and watch how the fires could be handled to make the work easier and to save coal. He did this for several nights. Gradually he became the best fireman the plant ever had. His steam chart was better; his coal record was better. There never was a shutdown on Sam's watch.

The Theory of Combustion

THIS PROBLEM gave the trouble man quite some concern. There was no doubt that Sam could be made doubly efficient if he could but understand a few of the simple principles underlying the combustion of coal. At length the story of CO_2, B.t.u., etc., was unfolded to Sam in such a way that he became deeply interested. He dreamed of little Oxygens shooting through that fire bed. They didn't care much for ashes, but they sure did like coal. When they saw a good looking piece of coal they grabbed it and then there was a hot time. Sam's Carbons and Oxygens were just as real to him as the sandwiches and coffee he had for lunch.

To make a long story short, the Theory of Combustion was brought down to Sam, instead of trying the less likely task of lifting Sam up to the Theory of Combustion.

Let us return to the chief. At the ripe old age of 29 yr. he had learned all there was to learn. Now he was ready to retire into something soft.

The trouble man approached the manager with a delicate proposition. Fire the chief and make Sam head fireman. This manager was progressive, energetic, and a good business man, but to place a colored man in charge of the boiler room was traveling a little too speedy for him. He promised to think it over.

Then came the hot spell. For one whole week the thermometer flirted with 100. The day fireman was a husky Italian, but he caved in and quit. The chief engineer took a hand, but they carried him out. Meanwhile the superintendent had scared up another man who had had experience in firing, but he threw down the scoop after an hour.

As a last resort someone thought of Sam. Sam had just finished an eight-hour shift and had gone home to bed. He came down and finished out the watch.

A Pinch Hitter

ON THREE consecutive days Sam worked 16 hr. at a stretch, while the mercury glued itself to the 100 mark. Four different men had tried and failed. Someone asked Sam how he did it.

"Ah sits down in de doah an' cools off when Ah gets all het up," he replied with his characteristic drawl.

This answer didn't seem to satisfy, for they asked him how he found the time to sit down when the other men couldn't.

"Oh, Ah don't work dat a way. Ah burns de coal; Ah don't shovel it on lak dat. Ah couldn't stand it never ef Ah had to work lak dose yere boys."

That was several months ago. Today Sam is head fireman. His pay envelope is much fatter. He doesn't shovel coal any more. He has broken in three new firemen and they fire Sam's way—the way he learned from the trouble man.

The trouble man dropped into the boiler room the other day. He found Sam busy as usual.

"What are you doing, Sam?"

"Oh, Ah's jes' pluggin' up a few ob dem leaks what you all wuz talkin' 'bout, boss."

The figures in the office told the real story. Production had been boosted 6 per cent above its former figure. The 1:1 mixture had been cut down to 2:1. Sam had successfully burned 3:1, but the superintendent had to call a halt because the supply of screenings ran low. Best of all, instead of burning 30 tons in every 24-hr. day, Sam was carrying the load on only 18 tons.—FECONY.

One Engineer's Part in Winning the War

YOU know that last spring I took on that job we were talking about as manager. They say I have made good, and I am going to stay with it a while longer, unless they try to induce me to do too much work; then I am going to balk.

"When things began to get busy across the water, and Uncle needed men, why he naturally had to soak me first by taking away my best ones.

"I want to give them back their places when they return, and in the meantime tried to get along with inferior help until that time came, and so have been a very busy man. For instance, it is now 6 a.m. and I have been at work an hour, and I did not get into bed last night till 12 o'clock, and was WORKING till that time; but just now my chief engineer called me to come to the plant at once. I asked him what was the matter, and he said a certain pipe had frozen and he did not know what to do.

"Now this pipe is a vertical pipe, 26 ft. long, and runs up the outside of a steel water tank that is full of water, and all on earth he had to do was to wrap some rags around the bottom at the ground, pour on some kerosene and set it afire, and in 3 min. the job is done. I am telling you this to show you what type of men the government has left us out here in the sticks to work with, and I assure you that this man is above the average.

"Now in addition to this sort of trouble I am filling and am successfully holding down the jobs formerly held by the manager, the chief engineer, the chief electrician, the trouble man, the water department pumper (pumps are 5 mi. out) and office boy, and help the cashier with the books.

"So you see that I am about, not loaded DOWN, for I could do a LOT more, but am out of time.

"If it wasn't that my wife insisted that I come home once in a while and see the babies, and change clothes, why I could get rid of one more man and take it over myself, but she is a very obstinate woman and has to be humored.

"Seriously speaking, I am doing, alone, with two men and a girl, the same work that eight men did before the war, and each of them thought he had a lot to do; and I am slighting none of it at that.

"In addition to this I have installed—superintended—a new 250-hp. Diesel engine and its attendant equipment, built a new building around the Diesel plant, moved and rebuilt the switchboard, dismantled and sold the old steam plant, moved my office and done some remodeling there, wired and put 112 new houses on the line since June 15, built one mile of new extension and rebuilt a lot of the old lines.

"I have had one engine—the only one I did have before getting the new one going and after having taken out the steam equipment—and I had to drive it continuously since July 1, with only an occasional stop to examine my oil; and I was expected to give good service and all they wanted of it, by the public. And this three-cylinder engine had two cracked heads, and two cylinders cracked clear through the jackets and into the bore.

"So that you can judge the pleasure it was to keep it going and to give service. It is still in that condition, and will be until I can get the material from the shops to repair it.

"This material has been ordered since last March, but the government would not let them turn it loose; they think now that we can have it about Feb. 1.

"Thus have the small industries had to live and render service, so that I feel that if ever any one human did his bit in this war it has been your uncle. I have no complaint to make, but would do it all over again, merely remarking that somewhere in Washington is a d—n fool who knows but little about the business that he tried to put over; for it does seem that the small potatoes were worth saving also, as well as the larger ones."

JOHN PIERCE.

Conserving Business

WHEN the Federal Trade Commission was established it was the hope of its partisans that it would become an agency for fostering business, charting the course along which firms might safely sail and setting buoys to mark the danger limits, also pointing out ways in which business organizations might expand and the commerce of the country, both domestic and foreign be increased without danger to the rights of the consumer.

The United States Chamber of Commerce, in a report of one of its committees has pointed out how far the commission has failed this hope. Instead of becoming a stable body, numerous changes have taken place, and at present only three of the five places are filled. Also the function of the Commission has become one of prosecution and restraining business rather than advising and encouraging.

To accomplish the purpose originally intended, M. L. Requa, head of the Oil Division of the Fuel Administration, has proposed a National Board of Trade to handle relations between industry and the Government, and a bill is being drawn for Congress to establish such a body.

That plan calls for a body to counsel, advise and regulate industry that closely parallels our present Supreme Court in its manner of appointment. Its members would be selected from those captains of industry who had reached the highest pinnacle of success the business world holds for them, whose success had been unblemished in every relation of life. A place on that body would be looked upon as the crowning glory of a successful business career. It would be something for a man to strive for after he had reached the point where further business ventures had no appeal. Its members, by their appointment, having given up all ideas of returning to business practice themselves, would take up a position aloof, using their wisdom and experience to aid and counsel business generally, and to guide it in its relations with this and other governments.

The full details of the organization of such a body to supervise and advise the industry of this nation in its relations with the Government are lacking as yet, it is true. The fundamental idea, however, seems the best that has yet been advanced along its line. That supervision and regulation of industry by the Government

is to come to a greater degree in the future than we have experienced in the past, but few will deny. Again, if the business interests in this country are to secure anything like a full measure of co-operation with the government, which is necessary if they are to compete with the business of other nations in the foreign markets, such regulation and supervision has got to come.

The bill should provide for a body that can actually guide, counsel and regulate and for a method of appointment that shall insure the best business brains of the country being found on that board and individuals of mediocre ability being excluded.

In all other great industrial countries, the Governments are encouraging co-operative action of firms in a given industry and in similar industries to insure stable markets for raw materials and manufactured products and to secure the most efficient methods to all manufacturers. If we are to conserve our industries in face of competition, we must adopt a like course and a National Board of Trade seems the most feasible means of encouraging such action while restraining from abuses and regulating activities so as to safeguard the rights of the public and of buyers.

Business must live and prosper if employment is to continue. Hampering of business means less work and less wages; hence the interest of everybody is bound up in continued industrial and commercial growth, and it behooves us all to help make public opinion that shall demand the adoption of measures to preserve and help our industries.

Fighting With Canals as Weapons

ONE METHOD which Germany is following out to gain commercial advantage is worthy of our thought and attention. Much of the merchandise supplied by Germany to other European countries came from overseas, and would naturally be shipped through the nearest port. But the interior canal system, connecting the various rivers, has furnished a delivery cheaper than rail transportation, hence has enabled German firms to underbid on foreign goods.

In the past, the Rhine and the Danube have been the great basic arteries, the Rhine connecting through the Aar to a system of canals in Switzerland, joining up its lakes. Now it is planned to connect the Rhine to the Danube by two links, the first going through Switzerland by way of Constance to Ulm, the second from Mainz by way of the Main River to Nuremberg and across to Ratisbon, on the Danube. This will give a direct water route connection from Rotterdam to Vienna and Budapest, and on to the Black Sea and the Balkan states. It is also planned to connect the Elbe River, whose seaport is Hamburg, to the Danube by a canal having a terminal at Pressburg, in Austria, thus giving a second line to the Balkans and the Black Sea region.

A third connection would be from Pressburg by way of the Oder River to the Baltic Sea, with crossover through a canal already completed from Stettin to Berlin. This system would carry at all points barges up to 1200 T. capacity and would furnish cheap transportation from Holland and German ports to Switzerland, Austria and all interior countries and to ports on the Baltic and Black Seas.

A commercial network will thus be formed binding together the Middle Europe that Germany was not able to conquer by force of arms. This is a legitimate commercial ambition, but indicates the kind of competition that must be met in future trade. As an offset, a system is proposed to connect Marseilles to the Rhone and thus by another canal to Geneva. Switzerland has had plans for a connection from L. Geneva at Lausanne to L. Neufchatel, thence to L. Bienne and the Aar River to the Rhine. A second railway is needed from Limoges to Geneva to connect Atlantic ports to Switzerland. For traffic from the East a canal is under way from Venice to Milan, and a rail connection through Locarno to the Swiss lowland country. This will tend to draw traffic through the shorter Rhone River track rather than by Rhine or Danube to Switzerland, and Eastern Europe can be reached by rail and canals from Mediterranean ports as cheaply as from the North Sea, provided the attention of trade-seeking nations is given to perfecting these routes.

These world problems of commerce are no longer alien to us, as they concern, vitally, our holding the trade we now have, and reaching out for more. It is essential that we learn to interest ourselves in whatever may react on our industries, realizing that only as industry and commerce grow in America can we hope for large opportunities and better pay.

Our Gas Service

SOME interesting facts in regard to our war activities are now beginning to appear. For instance, when the armistice was signed Germany was producing 30 tons of poison gas a day, England about the same, and France even less, while the U. S. A. during September and October were producing 200 T. a day and were just getting well started. One plant was to cover 200 acres, and in a small part of it 100 T. a day of chlorine was produced and 112 T. of caustic as a by-product.

And this work was as dangerous as trench warfare. During August the casualties in the mustard gas plant were 3.5 per cent of the working force a day. Many were injured for life; not a few gave their lives in the service.

Big U. S. Air Boat

WE HAVE become accustomed to the stories of diminutive fighting airplanes with high-power engines, which fly at 150 miles an hour and climb at the rate of 1000 ft. a minute. We have heard frequently of the big bombing planes, and something of the experimental work of Italy and Great Britain with passenger planes.

But our own navy has now a flying boat which carries 50 passengers with ease. Its wing spread is 126 ft., length 70 ft., height 25 ft. It is a biplane, with wings 12 ft. from front to rear and is drawn forward by three 12-cylinder Liberty engines driving 4-bladed screws. The fuel carried is 300 gal., which, with armament and military equipment, will serve for 40 to 50 hr. flight.

STINGINESS puts savings in a sock; thrift puts savings into a home.

Home-Made Coal-Handling Device

THE ACCOMPANYING drawings illustrate a coal unloader designed and made by the writer and used at a plant where the coal had formerly been unloaded by hand at a cost of $5 to $5.50 per car, the coal now being unloaded by the regular force at the power house. Besides reducing the operating expense it reduces the time that a car is being unloaded. A car can be released in about 3 hr. after being placed at the bins, which, due

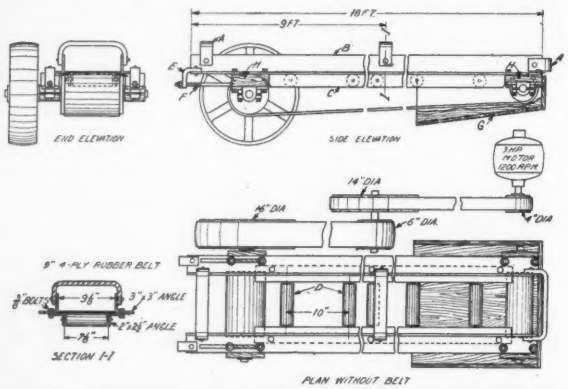


FIG. 1. ELEVATIONS AND PLAN OF COAL-HANDLING DEVICE

to the car shortage in the past, is quite an item.

This machine is used in connection with a portable machine, which was purchased and is used to distribute the coal and to load a 5000-lb. truck for the boiler room. The machine will handle about 40,000 lb. of pea and slack coal per hour.

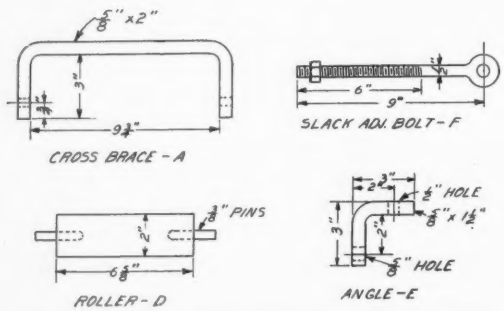


FIG. 2. SOME DETAILS OF COAL-HANDLING EQUIPMENT

A pit was excavated under the track as shown in Fig. 3 and lined with concrete.

The machine made by the writer was of the dimensions shown in Fig. 1 and driven by a 3-hp. motor. A 2-in. belt was used from the motor to the counter shaft, from a 4-in. to a 14-in. pulley; a 4-in. belt from the counter shaft to the machine, from a 6-in. to a 16-in. pulley. A chain drive was tried, but a rubber belt was found to give better satisfaction and smoother running.

The frame of the machine is made of 2 pieces of 3-in. angle iron held by braces A, A, A. Under the 3-in. angles are bolted two 2 by 2½-in. angles as shown in section II, Fig. 1, which act as bearings for the 2-in. hardwood rollers, which support the belt. The 2 by 2½-in. angles are set as shown, so that the belt will lap them about 1 in. to prevent loss of coal. The belt used being a 4-ply rubber belt 9 in. wide, which runs over a 4-in. pulley at the foot of the machine, and a 6-in. pulley at the head.

The eyebolt, F, in Fig. 2 is shown in place in Fig. 1, and is used to tighten the belt, the head shaft bearing being set on a hardwood block, H, Fig. 1; the bearing bolts are set in slots, as shown in plan Fig. 1 in the 3-in. angle irons.

Figure 2 shows dimensions of bracket E, and rollers D. The foot of the machine is cased in on each side and the end for a distance of about 2½ or 3 ft., depending on the distance that it extends into the pit, to prevent any coal from getting under the belt and clogging it. With this machine I have unloaded a 100,000-lb. car in 2 hr. and 45 min. from the time that the car was placed until it was released.

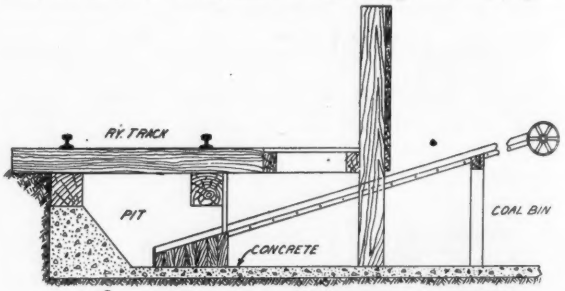


FIG. 3. METHOD OF APPLYING COAL CONVEYOR

The cost of the material for building this unloader, exclusive of the motor, was about $75.

R. L. MOSSMAN.

Air Compressor Troubles

SOME TIME ago a small belt-driven vertical air compressor was installed in a certain boiler room where there was considerable dust due to the handling of coal and ashes. It was necessary to extend the 1½-in. inlet pipe outside of the building. As the unloader was of sensitive construction, and as the least bit of dirt would make the pistons stick, causing poor regulation, considerable power was wasted because of the safety valve on the receiver releasing continually.

It was desired to connect the pipe as direct to the compressor and with as few fittings as possible, which

located the end of the suction pipe between the eaves of three roofs. To keep it free from water and other obstructions a hood was made from 6-in. galvanized sheet metal pipe with a 2-in. galvanized pipe nipple. These parts were all taken from used material found about the factory. This arrangement has worked satisfactorily for about a year, and it has never been necessary to clean out the unloader nor has there been any trouble from poor regulation.

MARK MEREDITH.

Dry Boiler Destroyed by Heat

I SAW a boiler the other day that had been fired for hours with no water in it. The fire sheet from fire line to fire line was distended like one of those little round-bellied jugs our grandfathers used to keep their bitters in. The boiler was in battery with others and carried 90 lb. till the fireman discovered its condition and pulled the fire and shut the steam off. It took some nerve but more likely some ignorance. He said he could see the sheet coming down while drawing the fire. Heads were sprung 1½ in. without pulling a tube out of the sheet. I suppose they were red hot. The soot on top of the boiler was burning. It was an old boiler; it rather upsets the theory that boiler plate becomes brittle, does it not? I have seen some queer things that happened to

LOCATION OF BULGE IN BOILER PLATE

boilers, but think this is the most wonderful sight I have seen along that line. There was only one crack developed, about 4-in. long. I wanted a photograph, but was unable to get it. The boiler was cut up with a torch, or at least they said they would get it out that way.

J. O. BENEFIEL.

Incompetent Engineers

IN THE Aug. 1, 1918, issue of Power Plant Engineering I read with interest the article by J. W. H. Eshnaur entitled "The Incompetent Engineer." Now, most of the readers must be aware of the condition prevailing on your side, but they cannot have any idea about the conditions prevalent in India, a vast country of about 320,000,000 population, which is really a continent of different peoples speaking different languages. Proportionately, there are very few power plants in comparison with those in the United States and in Europe.

Here boilers and power plants are under the control of the Board of Commissioners of different provinces, and licenses are granted by the Board of Examiners appointed by the government. The test of examinations is so simple that the questions put for the candidates of third class on your side cannot be answered by some of the first-class engineers of this side. This I can say from what I read in Power Plant Engineering. The act is called the Boiler Act, and it is strictly in force throughout India, except one or two provinces; that is a certified engineer is supposed to be in charge, wherever there is a steam boiler, of whatsoever horsepower it may be. There are three classes of engineers—third, second and first. They are called engineers, but there are engineers and engineers. The scale of payment is variable, sometimes a first-class engineer in charge of a mill getting $100 to $200 a month, while another holding the same certificate and supposed to do the same work (sometimes more) as the former one gets a salary of $20 to $30 a month; and engineers of lower grade work for from $10 to $15 a month. This irregularity of payment is owing to some of the employers keeping engineers only because it is required by the government; otherwise, they would be quite contented to employ a man who knows only how to start and stop an engine.

Here labor is very cheap in comparison with that of America. So a good fireman or an oiler can be had for a monthly wage of from $5 to $7. These men, most of whom are illiterate, after working for many years in that capacity, are given their third-class examination, and if they come out successfully, they are called engineers, and take charge of small plants. This third-class examination is taken orally only, and the test consists only of knowing the names and functions of the various parts of engines and boilers, and how to handle them. These men have no idea of combustion or economy of fuel, etc., Some of the higher class, that is, second and first-class engineers think their knowledge is perfect and finished as soon as they get their certificate. They do not read any technical books or trade journals, nor do they acquire up-to-date knowledge of latest improvements in appliances of their line.

The writer knew of a first-class engineer who, when asked by his favorite apprentice to lend him a book (which was considered as a text book on steam) for his study, he was told by the engineer he did not remember where the book was; that as he had no use for the book after passing his examination he might have sold it.

A man who had no knowledge of sizes and proportions of engines and boilers had ruined his employer. The employer had bought a second-hand plant, an ice factory, and changed to an oil mill, but as the engine was not powerful enough to work those oil mills, the man in charge advised the employer to buy a second-hand, double cylinder noncondensing engine of larger size, which he knew was in excellent condition and could be had cheaply.

The engine, although old, was in quite an excellent condition. After the engine was bought, erected and worked it was found that the boiler was not of sufficient capacity to supply steam. Again the employer was advised to buy a new and larger boiler, which, not being available locally, was to be imported from England. Up to the time (nearly six months) the boiler was in position, the factory was stopped. When it was restarted the engine did work and the boiler did supply the steam, but the coal consumption was so much that it did not pay to work the plant, and so it was stopped, and stopped forever. The employer became bankrupt and the plant was sold off to pay his debts. During these changes a practical and competent engineer was consulted, who agreed to undertake and work the engine efficiently and economically, if the employer would accept his terms, pay his fees and would do according

to his advice. However, the fees were found too high, and the matter was dropped; the result was his (employer's) total ruin.

A company was formed to build a big cotton manufacturing mill, and before the capital was subscribed, the managing agent, who pretended to know everything, came across an old engine which was going very cheap, bought it at once for the future mill. Now only one-twentieth part of the capital was subscribed, which was already spent in purchasing land, engine and economizer and in construction of the building.

There was no plan or any detail of the proposed mills; everything was done by the managing agent according to his own views, without consulting a millwright; as there was no more money, the building and engine without erection lay idle for 2 yr.

Anyhow, a small amount of more money was realized, and arranged to order out a few weaving looms. The number of horsepower required to drive those looms with preparing machines was about 100 hp., while the engine was of 900 hp. How can efficiency and economy be expected from such plants?

These are the ways in which some of the power plants are managed here, and they fail. Of course it does not mean that such is the case everywhere. There are some men so competent that their word only is considered as the highest authority on the subject.

The purpose of this letter is to give an idea of how incompetent men may ruin their employer or waste the public money, and sometimes frustrate the industrial development and prosperity of a country.

N. N. Bava Adam.

Coal Saved by Use of a Gage

My vapor heating system gave me considerable trouble for quite a while after it was installed, due to the fact that the pressure gage was improperly connected up. Figure 1 shows how this was done. The

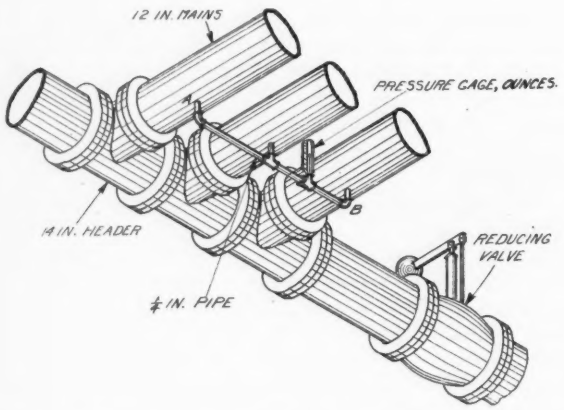


FIG. 1. ORIGINAL GAGE CONNECTION TO HEATING SYSTEM HEADER

¼-in. connecting pipe filled with condensate to such an extent that it affected the gage reading, giving an incorrect idea of pressure conditions. The connecting pipe, being below the header, was attached to the 12-in. mains and filled with water from A to B, which caused extra pressure to be registered on the gage C, due to the head of water which did not remain uniform.

After putting the gage on top of the header, as shown in Fig. 2, we get correct pressure indications and, incidentally, the whole system works satisfactorily, as I can now furnish heat to the building under definite

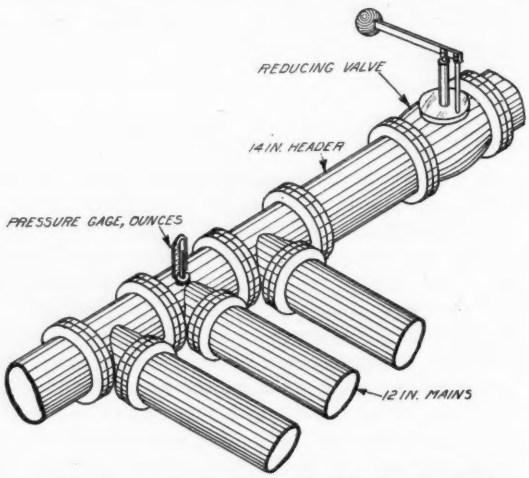


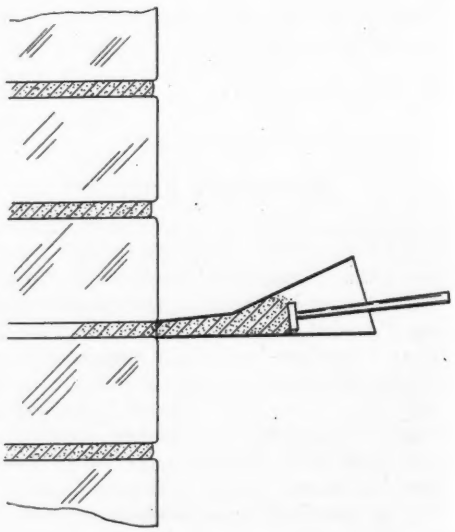
FIG. 2. GAGE PLACED ON TOP OF HEADER

pressure and can regulate it more uniformly. This simple change has resulted in a saving in coal of 300 lb. daily.

Earle H. Gray.

Calking Boiler Settings

The job of filling up the crevices between the bricks of boiler settings is of importance in cutting down excessive air leaks, but the work is time consuming and is



A CONVENIENT MEANS OF CALKING BOILER SETTINGS

usually attended with a lot of waste material, especially important where somewhat expensive plastic cements are employed. Where considerable work of this character must be done, a great saving in time and material can be effected by using a form and rammer, as shown herewith,

applying the cement or calking material directly to the point of use. For convenience in calking the short vertical spaces, the width of the spout should be made about 2 in.

M. A. SALLER.

Securing Foundation Bolts

ABOUT a year ago I took charge of three electric elevators, the engine beds of which were fastened to a concrete floor with split expansion bolts, as shown in Fig. 1. After the elevators were used but a short time, the engine beds became dangerously loose, so that I had

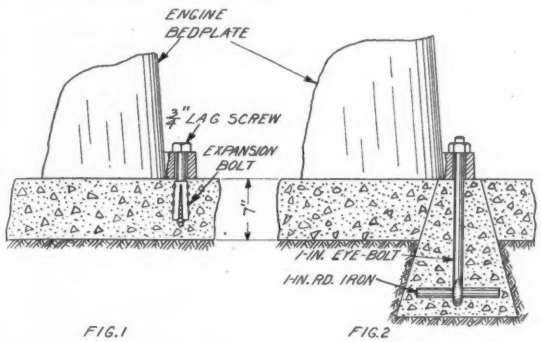


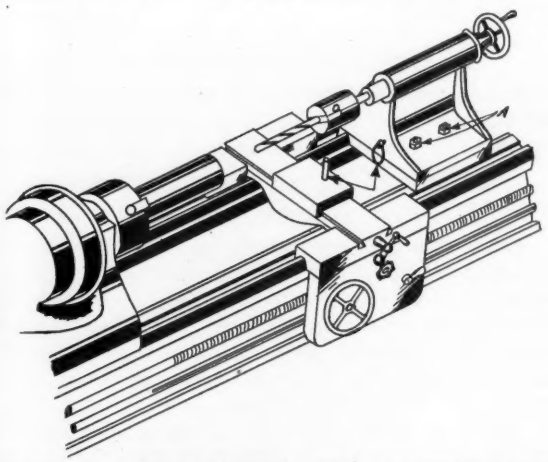
FIG. 1. ORIGINAL SCHEME EMPLOYED TO SECURE BOLTS
FIG. 2. EYE-BOLTS WITH RETAINING BAR AND MANNER IN WHICH IT IS UTILIZED TO SECURE ENGINE BED TO FOUNDATION

a conference with the engineers employed in the plant, and the scheme shown in Fig. 2 was advised and adopted. The elevators have been running about a year since repairs were made and carry very heavy loads at times, and have not shown the slightest signs of loosening up.

C. S. TOMPKINS.

Automatic Feeding of Lathe Drills

WHEN USING a lathe for drilling, the arrangement indicated in the accompanying illustration will eliminate



HOOKING TAIL STOCK TO STEEL BOLT AND SETTING FEED SCREW ELIMINATES OTHERWISE NECESSARY ATTENTION TO DRILL

much otherwise constant attention and manipulation of tail stock feed.

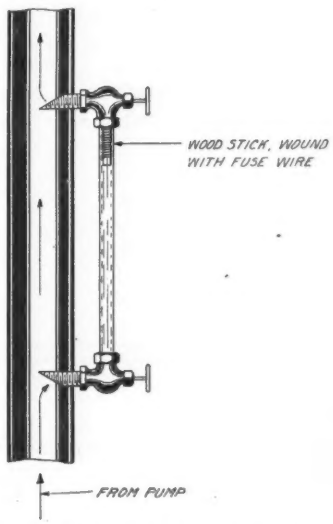
The tail stock is provided with an eyebolt carrying a ring which, when hooked onto the stud bolt shown attached to the lathe carriage, will upon tightening of the feed screw knob provide the necessary degree of feed.

This method is considerably easier than feeding by hand, especially with large drills. A little oiling is all the operator is required to do. DANIEL SCHIFFBAUER.

Readily Constructed Flow Indicator

TO OVERCOME considerable trouble experienced by inability to determine the direction in which water was flowing through a pipe, I adopted the scheme indicated in the accompanying illustration. A gage glass was provided and attached as shown, the connecting nipples beveled and extending into the pipe.

Within the gage glass was placed a cylindrical piece of wood wound with sufficient fine wire to cause this indicator to sink slowly, so that with the flow of water



FLOW INDICATOR AND METHOD OF APPLICATION

from above, the indicator, due to its weight and action of the water, will assume the bottom position. With, however, the flow from below, the indicator will rise and remain near the upper gland.

P. J. JOHNSON.

Surface-Hardening Copper and Bronze

THE HARDEST cupro-tin alloy is composed of 73 per cent copper and 27 per cent tin. Where this is found on a copper soldering bolt which has been "burnt," it takes a good file and much labor to remove the hard metal. By adopting the same method of surface alloying, a similar hardness can be secured, and the surface of copper and bronze made practically proof against filing. The copper or tin alloy is kept at a full red heat under a coating of tin for some time, the surface forming an alloy of the maximum hardness, although care is necessary not to overdo the matter.

MARK MEREDITH.

LET'S MAKE America a better place in which to live. Build now the homes, churches, schools, and roads which the war stopped.

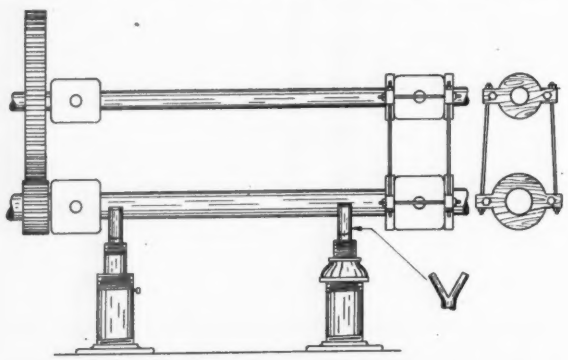
W. B. WILSON, SECRETARY OF LABOR.

Simple Jacks for Lining Shafts

WHILE REBABBITING a number of boring machines, I experienced considerable difficulty in lining up the driving shaft. Not being able to obtain anything which would hold the two shafts in line and parallel to one another, I began looking about the scrap pile in search of something which might aid me.

At last I secured two pipe flanges, each with a 1¼-in. opening. To one of them I attached a double strength nipple with a second ¾-in. nipple inside of that. In a properly tapped hole ⅜-in. from the top of the 1¼-in. pipe, I put a ⅜-in. set screw by means of which I secured a Y-shaped bracket made by splitting a 1-in. bolt and of the form shown in the accompanying illustration.

The other support was made with a reducing bushing secured to a 1¼-in. nipple which, as in the case of the other, was supported by a flange. A ¾-in. nipple with



JACKS MADE FROM OLD PIPE FITTINGS AND THEIR APPLICATION

running thread and working within the reducing bushing acted as a jack, thus allowing me to line up my shafts with considerable accuracy. W. DAVENPORT.

A Handy Mica-Cutting Tool

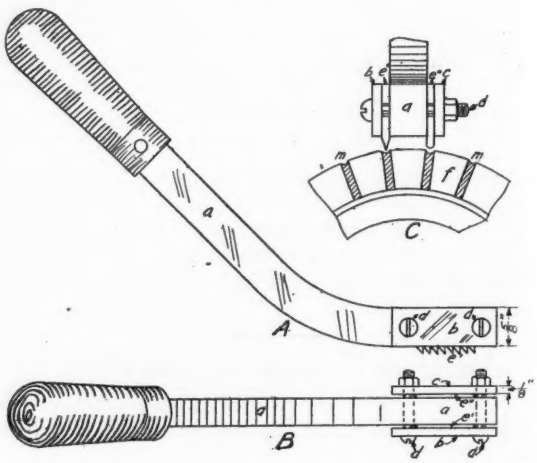
MOST ENGINEERS who operate direct-current machinery have more or less trouble with the mica in the commutator wearing more slowly than the copper and thereby causing brush trouble. Grinding down the whole surface improves matters for a time, then there is the same trouble again.

When cutting down the mica a certain distance below the surface, almost any kind of a tool that is thin enough is liable to be used, and after using files and saw blades for some time I saw a tool for the purpose used by an erecting man and made one on the same lines as is shown by the accompanying sketch.

By taking the piece of steel, a, one end was filed or ground to the exact thickness of the copper segments and the other end was forged similar to a file handle shank and fitted with the handle as shown. This piece must be made in conformity with the room available to work on the machine.

At c is shown an end view, and it will be seen that the parts e′ and e″ are the cutter and guide, respectively. Parts b and c are straps to hold them in position by means of bolts d.

The mode of operation is plain. First, get one slot cut down; then inserting piece e″, this will guide the cutter e′.



DETAILS OF MICA CUTTING TOOL

The cutter and guide may be made of pieces of hack saw blades. G. H. KIMBALL.

Rendering Concrete Wearing Surfaces Non-Slipping

FLOOR SURFACES are usually rendered non-slipping by means of grooving, and many other forms of indentation made by means of metal stamps or brass rollers having studs or channels on their revolving surfaces. There are, however, occasions when these expedients are not possible, and it is then that the use of emery may be put to good advantage.

Emery is manufactured in various grades, but that known as flour emery is principally used for concrete steps and landings, while a granular form is used chiefly for gradient concrete surfaces.

It is quite unnecessary and wasteful to mix emery throughout the whole thickness of the concrete. Such surfaces are usually topped with at least 1 in. of grano-

lithic concrete, through which the emery flour or coarser grained emery is mixed. Steps, for the sake of appearance, are usually troweled smooth; other surfaces may be left from the straightedge, although, should the occasion arise, granular emery may be sprinkled over the soft concrete surface and slightly pressed in flush with trowel or handfloat. One pound of emery flour mixed with two parts granite, ½ pail of granite-sand and 1 of cement, mixed thoroughly in the dry state before wetting will, in an ordinary case, be successful.

Soldering Kinks

THESE TWO hints are for those who have the work of soldering to do. The charcoal stove is made from an empty 5-gal. oil tin, the top being cut out and a sec-

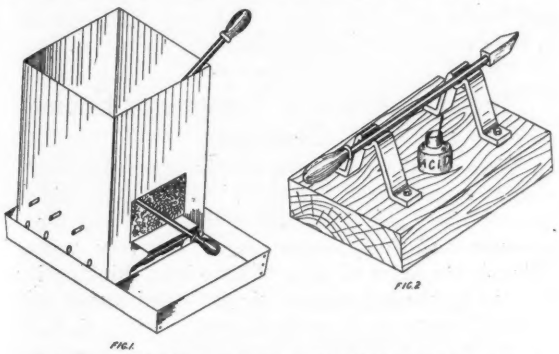


FIG. 1. CHARCOAL STOVE MADE FROM OLD OIL CAN
FIG. 2. HOLDER FOR SOLDERING COPPER

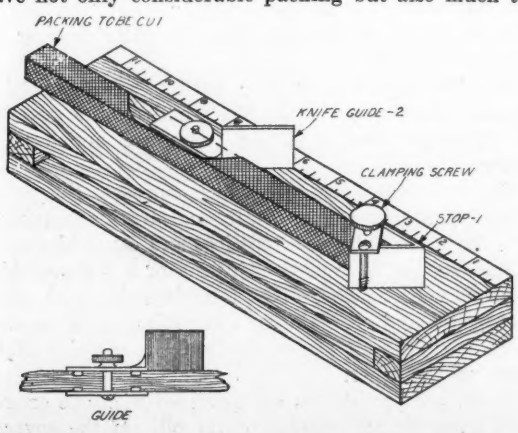
tion of one side cut and bent to form a furnace opening. Small rods are used for grates, and the whole sets in a pan for safety first reasons, keeping the fire from falling on the bench.

Figure 2 shows a neat manner in which to make a holder for the hot soldering copper. It provides a place for one to set it down without danger of its setting fire to the woodwork of the bench. The base is made of 2-in. plank and into the center is recessed a hole to take the acid jar.

C. H. WILLEY.

A Convenient Packing Cutter

IN THE accompanying illustration is a packing cutting device by means of which I have been enabled to save not only considerable packing but also much time.



ASSEMBLY AND DETAILS OF PACKING CUTTER

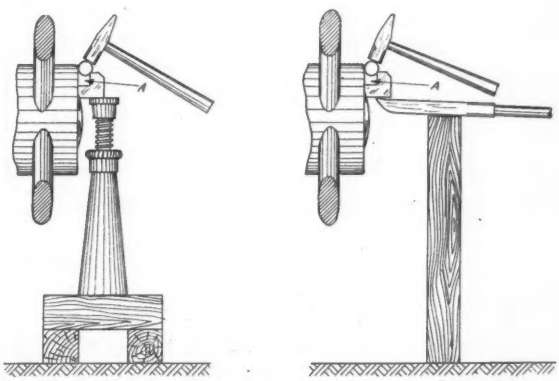
Essentially this consists of two hardwood boards, each nearly 12 in. in length and somewhat more than 3 in. wide, arranged and equipped as shown, with a rule for measurement of the packing to be cut, a stop 1 and a guide 2. The stop is of the form indicated and is secured to the board by means of two wood screws, while the guide, details of which appear at the bottom of the sketch, is so constructed as to allow shifting according to length of packing desired.

Cutting must be done with a sharp knife held along the outside of the guide.

ALFRED JOHNSON.

Extracting Keys

IT IS by no means my intention to criticize C. H. Willey's way to extract a key, but I have another scheme and have used it many a time; it does not take many tools—a hammer, a piece of round iron of suitable size and a jackscrew or a crowbar, applied as shown in the sketch.



METHODS OF KEY EXTRACTION EMPLOYED BY H. BAUGENMACHER

The jackscrew is set tight under the nose of the key, a piece of round iron about 12 or 15 in. long and of a thickness that it will fill out the space between the hub and the nose of the key and to *leave a space A* (as indicated in sketch). By holding the round iron with one hand and striking with the hammer in the other hand, the key is bound to come out; if a jackscrew is not at hand, a crowbar and a piece of wood will do, but the crowbar must be held tight under the key.

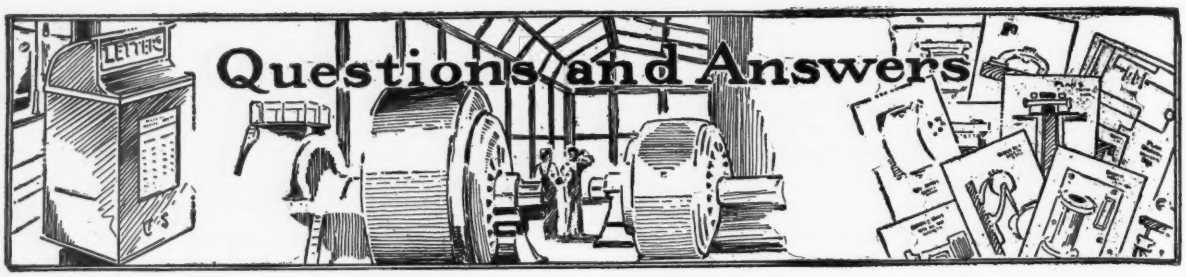
H. BAUGENMACHER.

Preservation of Wood

SEVEN YEARS' experience has proved zinc fluoride as a preservative of wooden poles. It compares favorably with copper sulphate. When complete impregnation of the wood is unnecessary, a partial application of sodium fluoride will be found to exhibit great preservative action.

LET'S ALL keep industry humming by working together, employers and employes, in harmonious co-operation.—U. S. LABOR DEPARTMENT.

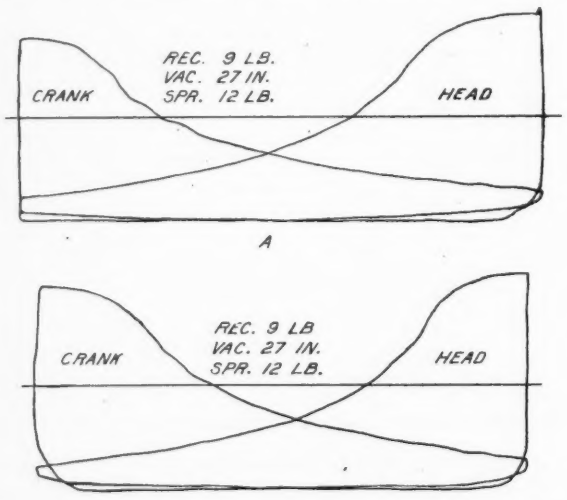
OWN A HOME for your children's sake.—W. B. WILSON.



Why the Difference in Cards?

THE TWO CARDS shown herewith were taken at intervals of 15 min. from the same engine, and I cannot understand the difference which appears to exist. Will some of the readers inform me as to their opinion on the subject, especially as to the peculiar shape of the crank-end diagram of the card A?

I wish to state that these cards were taken by different men, and further that during the 29 yr. this engine



CARDS TAKEN FROM SAME ENGINE AT INTERVALS OF 15 MIN.

has been in operation not a single repair has been made on it. J. M. L.

Why the Pound?

HAVING HAD considerable trouble with the hammering of my feed lines, I feel that I am in a position to offer some suggestions which may prove of value to C. W. A., whose difficulties were enumerated in the Nov. 15, 1918, issue.

If C. W. A. will observe the action of his pump he will undoubtedly notice that one side comes to a stop before the other starts, thus allowing the water to flow backward momentarily while the boiler check valve is closing with more or less of a slam. This may be the cause of his hammer.

If he will take notice, I think he will find that this is particularly true after pumping cold water for a while. He may also discover that at times his pump will have a tendency to stick at the end of the stroke and then perhaps start more quickly than it ought.

It is also possible that he may find the centers of his cylinders worn more than the ends, thus causing the piston to slip badly and the rings to tend to expand and wedge into place as the piston reaches the end of the stroke.

A pump under my charge acted in the same manner and it was not until after I had bored and relined the cylinders that the trouble subsided. A. L. A.

Irregular Action of Compressor Engine Governors

WHY DO the governors on the steam ends of ammonia compressors "jump"? I have considerable trouble along this line, and notice also that the back pressure and compression gages are very unsteady. What is the cause of this? I have been thinking it may be due to unequal expansion in the expansion coils or slugs of liquor in the suction lines. R. G. S.

A. There is no reason why the governor on a steam-driven ammonia compressor should be "jumpy" any more than the governor on an engine connected to a generator or other load.

The load on a double-acting ammonia compressor is practically the same during the entire revolution, and this is also true on the single-acting machines having two compressors. The weight of the flywheel will easily balance the slight variations.

A defective suction or discharge valve may cause a governor to jump, but when the defect is great enough to cause the engine to race the trouble is very evident and easy to locate.

A slug of liquid entering the compressor from the evaporating coils could cause the engine to slow down, but the pounding will at once notify the engineer.

The cause of a racing engine or unsteady governor must be looked for in the governor itself, the belt or chain which drives the governor, the valve gear or the valve setting.

See that the belt or chain is not too loose or slipping. Examine the pulley on the shaft and on the governor for tightness. See that the gears are not loose or broken.

There is also a bearing which supports the weight of the upright governor shaft, and if this bearing is worn the gears will mesh too close and cause binding.

The gag pot may need adjusting or a different kind of oil may be needed. Use a moderately thick oil in the gag pot and regulate the controlling valve or other device until the oil passes slowly from one side of the piston to the other.

Some gag pot pistons are provided with one or more small holes for the passage of the oil. If the governor is too sensitive, plug some of the holes, or if there is

only one, reduce its size by means of a bushing. If the governor is slow to act, increase the size of the oil passage or use a lighter oil.

See that the valve setting is correct. Use an indicator, if one is to be had.

Examine the valve gear for binding or for lost motion caused by wear.

Notice the toe plates on the back of the pick-up hooks. See that the riding edge is rounded so that it does not bind on the cam ring and stick. This defect is seldom found except when new toe plates are put on. Do not mistake toe plates for the dies on the pick-up side of the hooks.

Reasons for the waving or unsteady gage hands: The valves on the gage lines are open too wide and the gage spring is subject to the variations in pressure when the compressor piston changes direction of travel.

It is a good idea to fill about 12 in. of the gage line with ammonia oil. This will act as a cushion and help to steady the gage hand.

Just open the valves on the gage lines enough so that the hand will move just a little. Open the valves up wide once in a while to prevent them from blocking up with oil or other foreign substance.

A. G. SOLOMON.

Proper Division of Alternator Loads

I FIND, when running two alternators in parallel, some difficulty in dividing the load between them; also a difficulty in getting the incoming machine to pick up the load without the creation of heavy cross currents.

Both machines are separately excited and the voltage is regulated by hand.

I should be glad if you would explain to me the method of regulating the voltage by hand. Also the cause of the cross current between the machines and what voltage regulators are on the market suitable for separately excited machines. L. B.

A. In taking up the matter of parallel operation of alternators, we will assume that one of your machines is already in operation, while the other is not. After the incoming machine has been started, build up the exciter voltage to its normal value. Then, with the main machine up to speed, throw in the exciter switch, and, by means of the main field rheostat, build up the alternator voltage until it reaches a value equal to that of the operating machine.

Then, it will be necessary so to adjust the speed of your incoming machine as to bring it in synchronism with the machine already in operation. At the proper time, the main switch of the incoming machine may be thrown in. It then is a question of the proper manipulation of the field rheostats of your two machines. Just how these should be set we, of course, cannot tell you, but we are sure that, if you will experiment a little, you will be able to determine the setting for the proper division of the load, this, of course, depending upon the relative capacities of the two machines.

If the machines are of like rating, then the load would be equally divided between the two machines; but if they are not of like rating, then you will have to adjust your rheostats so that each machine carries its proper proportion of load.

Let us assume that one of your machines has a rating of 200 kv.a., while the other has a rating of 100 kv.a. If the entire load carried is 150 kv.a., you will have to adjust your rheostats so that the small machine will be carrying 50 kv.a. and the large machine 100 kv.a., thus indicating that each unit is operating at 50 per cent of its rated capacity.

In a like manner, should you be having a total load of 300 kv.a., then each machine would be operating at rated capacity; the smaller one carrying 100 kv.a. and the larger one 200 kv.a. If the exciter voltage in each case is as it should be, then, of course, there is nothing to be done with the exciter field rheostats.

The only reason we can see for the existence of cross currents between the machines is, that either they are not in synchronism or that their characteristics are such as to establish such cross currents. This frequently happens, especially in the case of machines having different characteristics, and it is of vital importance that, in planning an alternating-current installation, care be taken to see that the machines are of similar characteristics. If this is not done, trouble is bound to occur.

For detailed information relative to voltage regulators such as are suitable for use in connection with alternating-current generators, we would suggest that you get in touch with the General Electric Co., Schenectady, N. Y., and the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Graphite for Cylinder Lubrication

CAN YOU obtain for me any reports on tests of graphite efficiency for lubricating valves and cylinders using high pressure and highly superheated steam?

I. J. B.

A. It may be regarded as an axiom that the higher the temperature in a steam cylinder, due to pressure or superheat, the more important becomes the lubrication afforded by pure graphite because of the fact that cylinder oils lose body and are less effective as lubricants at these high temperatures, while the lubricating quality of pure graphite is the same at all temperatures. The particles of graphite fill in the microscopical pores of the rubbing surfaces and also provide a load-carrying-film or veneer which prevents metallic contact and greatly reduces friction. This reduction of friction is of great value at ordinary temperatures undoubtedly, but at high temperatures it becomes almost the sole reliance for lubrication and will effectively prevent sticking, groaning and excessive wear, which are so common in high temperature cylinders and valves. Pure graphite is, in fact, a solid lubricant which cannot be melted or squeezed out.

The reputation of graphite as a lubricant has suffered a great deal in the past through a popular misunderstanding as to the necessity for absolute purity. Most graphites on the market contain a serious amount of impurities, consisting of sand, flint and other forms of rock, all of which are gritty and, of course, have the effect of increasing the friction to such an extent as practically to counterbalance the good accomplished by the pure graphite contained. It is only when the graphite is 99 per cent pure or better, that the best results are obtained.

To purify natural or mined graphite to this high degree is practically impossible, requiring expensive

chemical as well as mechanical treatment which is seldom resorted to except for display or sample lots. The only pure graphite available in commercial quantities is that manufactured in the electric furnace, according to the patents of Dr. E. G. Acheson, who, by the way, also invented the well known carborundum and the process for making metallic silicon. The temperature attained in Acheson's electric furnace by means of Niagara Falls power is almost inconceivable, being sufficient to boil out all impurities, including sand, lime and the most refractory substances. In this furnace any form of carbon is transformed to the graphitic state and delivered absolutely pure.

This electric furnace graphite is supplied already incorporated with cylinder oil, for use in steam cylinders by means of a spray lubricator which delivers the oil along with the steam. It is also possible to obtain Acheson-graphite in combination with other oils and grease of varying characteristics to fit a wide variety of lubrication problems.

F. L. Koethen,
Supt. Lubricant Works,
Acheson Graphite Co.

Tightening a Crank Disk

I would like some advice regarding a loose crank disk. Where the disk goes onto the shaft is a key which shows signs of having worked out, and at one place on the shaft oil and rust have worked out.

Can the disk be reset, or what would be your advice?

A. G. E.

A. Before doing anything else to your crank disk, we would suggest that you try to tighten the key and note the results. If the key again works itself out, and there is no other evidence that the crank disk is loose on the shaft, it would, of course, then be preferable to let the matter rest.

If, however, you find that the key persists in coming out, and that the crank disk is still loose on the shaft, we would suggest that you remove the crank disk, also the key, and with emery cloth clean off very thoroughly both that part of the shaft to which the crank disk is keyed and the inside surface of the crank disk next to the shaft. Then obtain a very thin steel shim, of such length as to reach around the shaft. Place this in the crank disk opening and heat the crank disk. Then as soon as you have it at a good heat, place it upon the shaft, with the shim between the shaft and the inside face of the shaft opening of the crank disk.

Effect of Sodium Sulphate and Sodium Chloride

What is the difference between oxygen and an oxide, and what are the symbols of the latter?

In a feed water analysis, which was made by a professional chemist, I found that our water contains among other salts carbonate of lime (plain chalk), sulphate of lime (gypsum), sulphate of magnesia (epsom salt). Of the foregoing substances, I know what effect they have on the boilers and the feed water pipes, but the analysis shows that there is sodium sulphate and sodium chloride in the water.

What are the consequences of these as regards the boilers, pipes, etc.?

H. B.

A. Oxygen is an elementary gas, and is generally represented by the letter O, while an oxide is a combination of oxygen and some other element or elements. The method of representing an oxide depends upon the element with which the oxygen is combined. For instance, we have carbon dioxide (CO_2), which contains one part of carbon and two parts, as indicated, of oxygen. Then again we have carbon monoxide, represented by CO. In the same way, there are many other oxides, and, as in the case of the carbon dioxide and carbon monoxide, they consist of oxygen and some other element or elements.

Relative to the analysis which was made of your feed water, and according to which there was found sodium sulphate and sodium chloride, we wish to state that these salts are soluble in water and therefore have only an incrustation effect; that is, they merely form deposits upon the heating surfaces. Sodium chloride, as you perhaps know, is nothing more than common table salt.

Generating Acetylene Gas Under Pressure

Can you tell me whether there is any danger in putting a given amount of carbide in a tank and then forcing in through a valve just enough water to raise the gas pressure to 150 lb.?

The tank is strong enough to stand 300 lb. I have been told that it would explode when generated under pressure.

W. L. R.

A. Adding carbide to water generates acetylene gas, which is very dangerous when compressed to 30 lb. per sq. in. or over. It becomes very unstable and is liable to explode unless handled with extreme care. Compressing gas generates heat which in the presence of the unstable gas is very dangerous and cannot be stored in ordinary tanks with safety.

Tanks in which acetylene gas is stored are first filled with a porous material, such as a mixture of asbestos, charcoal, kieselguhr and a small amount of cement to hold it together; packed in the storage tank, this provides a finely divided porous filling that prevents disassociation.

Acetone has the property of absorbing acetylene and is often spoken of as dissolved acetylene. Acetone increases in bulk as it takes up acetylene. As the acetylene is drawn off the acetone shrinks in volume and the unfilled space is filled with acetylene under pressure, which is dangerous and therefore the above described principle of filling the tank with some porous material is taken advantage of because it is found that the gas will not disassociate when finely divided.

Copper Condenser Tubes; Salt Water Tests

Can copper tubes be used in connection with surface condensers? If so, why are they not more generally employed?

2. Where salt water is used for circulating purposes, how can the presence of this be detected in the condensate? In other words, how can leakage of the circulating water be discovered by testing the condensate?

W. H. P.

ANSWERS

COPPER can be, and is, used for condenser tubes, although when salt is present in the circulating water, more or less trouble is experienced on account of the resulting corrosion. Under normal conditions, it is undoubtedly due to the relatively high cost of copper that this material is not used exclusively for condenser tubes.

2. Ten cubic centimeters of the condenser water are measured out by a pipette, placed in a beaker, and two or three drops of potassium chromate solution added. A standard solution of silver nitrate is then added drop by drop from a burette, but only until the liquid in the beaker maintains a faint pink color on agitating. The volume of silver nitrate solution used is then recorded. Ten cubic centimeters of the sample of circulating sea water are now measured out, 90 cu. cm. distilled water added, mixed, and 10 cu. cm. of the mixture taken. A few drops of the chromate solution are now added, and the silver nitrate added as before, the amount of the latter used being recorded. The amount of silver nitrate used for the circulating water multiplied by ten and divided into the amount used for the condenser water and the quotient multiplied by 100, gives the percentage of sea-water leakage in the condenser water. The silver nitrate solution usually used is made up by dissolving 9.6 gm. silver nitrate in 2 liters of water. This is of such strength that 1 cu. cm. is equivalent to one milligram of chlorine.

Re-Ending Boiler Tubes

I WISH to ask you a question on bent boiler tubes of the Stirling type, as to having them re-ended about 6 in. in each end by the acetylene process. Is it as good as charcoal weld? If not, why? Why will not boiler insurance companies carry and pass on them? Why will they pass on a fire tube and not on water tube boilers?

E. A. W.

A. In regard to re-ending tubes in a Stirling type boiler by the acetylene process, I beg to state that I very much doubt if you will be able to find an insurance company that will write a policy on a boiler with the tubes so treated.

The principal objection raised by insurance companies to welded construction or repairs in steam boilers is due to the fact that the efficiency of a weld, at best, must be assumed. In fact, there are so many conditions that tend to make the actual strength of a weld more or less of a guess, that the insurance companies have in many cases forbidden their inspectors even to consider as a risk boilers having welded parts, this being especially so where the welded part is in tension—as would be the case with tubes in a Stirling boiler.

It may assist the reader to a better understanding of the insurance companies' viewpoint on this matter when it is explained that practically all policies written on water-tube boilers include tube failures. The reason for this is that the loss of a tube in a water-tube boiler means dropping that boiler from service until repairs are made, and, as will be readily understood, this is not the case with fire-tube boilers, many of which run for months with plugged tubes.

It would be well to keep in mind also the fact that water tubes are subjected to an internal or bursting pressure while fire tubes are subjected to a collapsing pressure—and this in itself is a serious objection to welds in water tubes.

I am personally rather inclined to favor charcoal welding, especially where the article to be welded is large in size, as this method of welding imparts a more even temperature to the article to be welded, which is an important consideration in all welding. In fact, I have heard the statement made that the charcoal process practically eliminates the human factor in welding, which is really the direct answer to good or poor welds.

A still further objection raised by some insurance companies against welded tubes in water-tube boilers is the fact that once the tube is installed it is not accessible for inspection, and no matter how thorough the inspector may be, he has absolutely no means of ascertaining the exact condition of the tube welds except in the outer sides of the tubes. I believe some companies have instructed their inspectors to insist on a yearly hydrostatic test on boilers with welded parts; but to the writer's mind the value of even this test is questionable, as the conditions under which a test is applied and the conditions under which a boiler operates are very different.

To sum the matter up, I should not recommend the installation of tubes re-ended by the acetylene process, if it is desired to have the boilers insured.

A. D. PALMER.

U. S. Government Safety Valve Rule

KINDLY give me the U. S. Government rule for the calculation of safety valve sizes.

R. G. S.

A. The rules of the U. S. Supervising Inspectors of Steam Vessels read that lever safety valves to be attached to marine boilers shall have an area of not less than one square inch to 2 sq. ft. of the grate surface of the boiler, and the seats of all such safety valves shall have an angle of inclination of 45 deg. to the center line of their axes.

Spring loaded safety valves shall be required to have an area of not less than 1 sq. in. to 3 sq. ft. of grate surface of the boiler, except as hereinafter otherwise provided for water-tube or coil and sectional boilers, and each spring loaded valve shall be supplied with a lever that will raise the valve from its seat a distance of not less than that equal to ⅛ the diameter of the valve opening. The seats of all such safety valves shall have an angle of inclination to the center line of their axes of 45 deg.

All spring loaded safety valves for water-tube or coil and sectional boilers required to carry a steam pressure exceeding 175 lb. per square inch shall be required to have an area of no less than 1 sq. in. to 6 sq. ft. of grate surface of the boiler.

Nothing shall be construed to prohibit the use of two safety valves on one water-tube or coil and sectional boiler, provided the combined area of such valves is equal to that required by rule for one such valve.

NATURAL GAS valued at $9,000,000 was wasted in one year in a certain group of cities and towns in Kansas and Missouri, according to figures compiled by experts of the United States Fuel Administration.

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Government Ownership

One of the big problems of the readjustment period is how the government is to let go of the public utilities that it has taken over during the war.

Nobody questions the need of government operation of railroads as a war measure, or the logic of the consequent control of express service. There is greater room for doubt as to the necessity for taking over telephone and telegraph systems, and there has been much wonder as to the motive for the eleventh-hour absorption of the ocean cables. But these are accomplished facts, and speculation as to why serves little purpose now.

The real question is, "What shall we do about it?"

Detail comparison of private and public operation is impossible because the government has done many things to reduce expense and equipment effectively which the private owners would like to have done before, but were prevented by law from doing. Also war conditions have forced the curtailment of service to civilians and to commercial traffic, so that the government has not been able to show what it could do under peace conditions that prevailed when the utilities were privately operated.

It is possible, however, to trace some indications that will be informing as to the probable result of continued government operation or of government ownership.

Two chief advantages claimed for government ownership are that, as no profit is desired, cost of service can be reduced; and that disturbance from labor disputes will be avoided. Neither claim seems to be borne out by experience.

Municipal lighting plants have usually proved costly to the taxpayers. Government construction projects have usually been subject to suspicion of graft and padding, even where guilt was not actually proved. Observation of cost and service on European systems does not show either good service or low cost. Experience with government bureaus and the red tape of bureaucratic methods is not reassuring as to ease and quickness of doing business under government operation, or of a spirit of gracious service from government officials and employes.

As to labor disturbance, the strikes of London and Montreal police forces, of railway employes in France, on our own Alaskan railway during construction, in shipyards under government control, show that public ownership is no safeguard against disturbance; and the tendency of government officials to yield easily to demands without much regard to their reasonableness or the effect on the public, because the burden will fall on the taxpayer, not on those in control of the utility, is a danger to the public interest that cannot be overlooked.

Another danger, political manipulation of government employes, is familiar in every city, is proved in the case of Italian government railways, is present in our own government departments and would be certain to appear in government-owned utilities. Civil service, designed to lessen this evil, is not proving entirely effective for this purpose, and is not improving the quality of the personnel in government offices. There

is a tendency for workers to stay in a position which does not give them their best opportunity for progress because their jobs are secure. And it is difficult to change employes who are obviously a misfit in the positions that they hold.

Bureaucratic control substitutes artificially fixed conditions for the natural laws of competition and supply and demand; hence it is injurious to the conduct of the business and deadening to the powers of the individual worker.

Public opinion and instinct are against government ownership, as is shown by the criticisms and protests appearing against proposals for continuance or further expansion of the policy. No benefit has so far been shown which cannot be secured by government regulation, wisely administered, to conserve the best interests of the public and free from prejudice and favoritism. Control and regulation are easily changed to suit changed conditions and correct mistakes. Ownership, once adopted, is irrevocable, and the long train of evils, which are almost certain to follow, must be borne or, if they become too great, eliminated with difficulty by revolutionary action which will involve great industrial disturbance and hardship. It is an easy transition from government regulation to ownership. No reverse gear has as yet been devised or tried out.

It is wise to go slow.

Business as Usual?

While it was soon learned, after we really got going on war preparation, that business could not be "as usual," the return to peace conditions may well be fashioned on that slogan. Some readjustments must take place to pass from war activities to peace manufacturing and trade, and prices, especially of raw materials, will probably be gradually adjusted to a lower level. But with government co-operation in transferring plants and adjusting contracts, and gradual release of excess supplies now held by the governmental departments, markets will settle to new conditions without a radical disturbance.

Probably one of the questions about which there is more discussion than any other is what will happen to wages. Unquestionably, in some lines the increase has been out of proportion to the increase in cost of the necessities of life, and these must be readjusted on the basis of prices of the commodities as produced for commercial markets instead of for government war work. In other lines, it would seem unlikely that there will be any great change except as cost of living, commodity prices and wages recede together from the wartime high level.

Of this readjustment we need have no fear, for the great part of the cost of all necessities and most luxuries is for labor; hence, the lowering of prices will precede or accompany any decrease in wages, leaving the buying power of a day's work practically unchanged.

At the present time, there is some uncertainty, but in the power plant field, many plants need a thorough overhauling or replacement, owing to severe and continuous running to meet the tremendous demand for power during the last 3 yr. While buying is conservative to avoid accumulating large stocks in view of a possible decline in prices, sales to take care of essential operation for the next year at least will fill the factories of power plant machinery and supplies to capacity.

The outlook is for good crops and good prices next year, and the foreign demand for food, clothing and machinery will, to a large degree, make up for government contracts that will be cancelled.

Throughout the country the feeling seems to be of optimism and that, with a possible slight disturbance for a few months due to changing over war work plants and relocating the men returning from government service into industry, business will go on as usual except that it will be of greater volume for both domestic and export markets than in the past.

Electric Water Heating

COMPARISON of heating water for domestic and industrial uses by coal, gas and electricity was recently made in a paper by H. O. Swoboda before the Engineers' Society of Western Pennsylvania. He shows that with an efficiency for coal burning outfits of 10 per cent, for gas of 20 per cent and for electrical devices of 80 per cent, a kilowatt-hour, 20 cu. ft. of gas and 2.25 lb. of coal are about equivalent in heating results. On this basis, for equal fuel cost with coal at $3.50 a ton, gas would have to sell at 20 cents per 1000 cu. ft. and electricity at 0.4 cent per kw.-hr. Coal at $5.25 a ton will be equal to gas at 30 cents and electricity 0.6 cent. Coal at $9.25 a ton will be equal to gas at 50 cents and electricity at 1 cent. Gas at $1 will be equal to electricity at 2 cents.

Convenience, effectiveness of apparatus, cleanliness, close regulation of temperature and low fire risk may frequently warrant the adoption of the electric heater, even at the higher cost.

As a side light, Mr. Swoboda stated that electricity at 4 cents has been found to compete successfully with gas at $1 for cooking. In cities like New York, Philadelphia and Pittsburgh it is not possible to use electricity with economy; but in Minneapolis, where the rate for electricity is 2.5 cents for amounts above 6 kw.-hr. per room per month, in Boston where the rate for current above 10 kw.-hr. is 2 cents, and in San Francisco with a rate of 2 cents for all above 30 kw.-hr. up to 90, and 1.5 cents for amounts in excess of 90 kw.-hr. it is possible to use electrical heating and cooking to advantage. In fact, several thousand such heaters are in use in San Francisco, and the number is increasing.

A convenient device is the instantaneous electric heater in a faucet, so arranged that there are three positions, shut off, cold water and hot water. This, on a new installation would do away with hot water piping and the heating of water to fill a long piping system, and would give economy which might well offset the extra cost for electrical energy. The device has not been pushed on account of the heavy short-time demand that it brings on the supply mains.

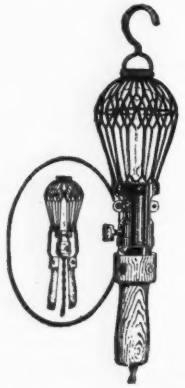
OF ITS available water power, it is estimated that the United States utilizes 24.9 per cent; Germany, 43.4 per cent, and Great Britain, 9 per cent. Such neglect of the Anglo-Saxon countries to utilize their water powers and thus conserve their fuel resources is little short of criminal waste.

Split Handle for Lamp Guards

A NEW departure in portable lamp guards is shown in the illustration of the Flexco split handle, which can be quickly attached to the well-known Flexco expanded steel lamp guards, made by the Flexible Steel Lacing Co. of Chicago.

This portable successfully fills a demand for a substantial handle guard which does not need to be wired. The halves of the guard, including the handle itself, open wide from the hinge at the bottom of the guard, and can instantly be closed and locked around the socket at the end of any extension cord. The cord itself runs through grooves in the handle.

The convenience of this new product will be appreciated by the motorist in his garage as well as in every



FLEXCO SPLIT HANDLE FOR FLEXCO EXPANDED STEEL LAMP GUARDS

factory, mill or warehouse, because it permits light to be safely carried to dark corners. Fire danger is avoided and lamp users readily see the advantage and economy, as the modest cost of the guard is quickly repaid through prevention of lamp breakage.

News Notes

FEB. 5-7, the fourteenth convention of the National Rivers and Harbors Congress will be held in the New Willard Hotel, Washington, D. C., and will be devoted to the broad subject of national transportation, under three heads: I. Railroad Transportation, including government ownership, return to private control, some intermediate plan of regulation and operation. II. Meeting Water Competition, covering differential railroad rates to waterway points and inland points, rates based on distance regardless of parallel waterways, and a slight difference in favor of points on waterways. III. Water Transportation, dealing with control of waterways by the Interstate Commerce Commission, and the establishing of through rail-and-water routes with fixing of maximum and minimum rates.

Delegates may be appointed by governors of states, mayors of cities and towns, presidents of commercial, industrial and transportation organizations, and should be given proper credentials. The names of delegates should be sent to the Secretary of the Congress, 824 Colorado Bldg., Washington, D. C.

The purpose is to promote enactment of legislation which will ensure a harmonious development of railroads, waterways and highways so as best to promote the interests of the country and its people.

AT THE meeting of the National Association of Practical Refrigerating Engineers, held at Oklahoma City, E. P. Tryant, Shreveport, La., was elected president for the coming year; J. E. Porter, Bartlettsville, Okla., vice-president; F. L. Brewer, Greenville, Miss., secretary-treasurer; Roy Noyes, Chanute, Kan., sergeant-at-arms. On the Board of Advisors, P. J. Jiminez, M. J. Boyle and F. B. Kay; Board of Directors, Chas. W. McGiboney, F. S. Brewer, J. E. Seger; Educational Board, J. B. Embrey, F. H. Ladd, C. R. Reynolds; Publication Committee, W. M. King, J. E. Brandt, O. K. Corken. Kansas City, Mo., was selected as the meeting place for the convention of 1919.

THE SPRING MEETING of the American Society of Mechanical Engineers will be held in Detroit, June 17 to 20, with headquarters at the Statler Hotel.

THE WAR TRADE BOARD announces under date of Jan. 3 that licenses will now be freely issued for the export to Denmark, Norway, Sweden and European Holland for a long list of articles, among which are: gage glasses, iron and steel and manufactures thereof (except high-speed steel), lighting fixtures of iron or steel. Licenses must be obtained, however, before shipment can be made.

HORACE N. TRUMBULL, who recently received his discharge from the Engineers Officers' Training School at Camp A. A. Humphreys, Va., has been appointed advertising manager of the Wellman-Seaver-Morgan Co. of Cleveland, Ohio. Before entering the service Mr. Trumbull was advertising manager of the SKF Ball Bearing Co. of Hartford, Conn.

THE CITIES SERVICE CO. of New York has announced the purchase of control of the Western Light and Power Co., northern Colorado, from Westinghouse, Church, Kerr & Co. The directors of Cities Service Co. have ratified the negotiations and new directors have taken charge of the company.

The power plant of the Western Light and Power Co. is at a coal mine near Lafayette, and the company furnishes light and power for Boulder, Longmont, Loveland, Greeley, Fort Collins, Milliken, Fort Lupton, Brighton and other northern Colorado towns. The main offices are at Boulder. Improvements to cost $1,250,000 are being planned by the purchasers.

THE CONTRACTS for the installation of machinery in the new hydro-electric power house under construction for the Burmas Paper Co., Inc., at West Dudley, Mass., have been awarded to James Leffer & Co., Springfield, Ohio; Electric Machinery Co., Minneapolis, and the General Electric Co., Schenectady, N. Y.

The power house, which will be 45 by 54 ft., of brick construction, one story high, and a concrete dam, 150 ft. long and 10 ft. high, are being erected under the direction of Thomas F. McGovern, a Southbridge contractor. The total cost of the building and dam is expected to be approximately $50,000.

THE POWER HOUSE of the Ithaca (N. Y.) Traction Corporation caught fire recently and burned to the ground. The damage to the plant is estimated at from $75,000 to $100,000.

THE QUIGLEY FURNACE SPECIALTIES CO. has opened a branch office in Providence, R. I., at 302 Turka Head Bldg., in charge of F. W. Reisman, who has been the Quigley Co.'s Eastern New England representative for (high temperature fire brick cement) and insulating brick, as well as the air transport system for distributing and burning powdered coal and other fuels.

THE POWER PLANT at Wellington, Ohio, is to be enlarged from 300 hp. to 500 hp. by the addition of either gas producers and gas engines or new boilers and a steam turbine. The work is in charge of C. E. Gadfield, Supt.

NATIONAL FOREIGN TRADE COUNCIL will hold its Sixth Foreign Trade Convention at Congress Hotel, Chicago, April 24 to 26. The formal call will be issued later.

ABRAM T. BALDWIN, president of the Precision Instrument Co., of Detroit, Mich., died on Wednesday, Jan. 8, at his home in that city.

Books and Catalogs

HOW TO IMPROVE THE HOT-AIR FURNACE is the title of Technical Paper 208 recently issued by the Bureau of Mines, Department of the Interior, the author being Charles Whiting Baker.

O. P. Hood, chief mechanical engineer of the bureau, in reviewing Mr. Baker's paper, says: "Hot-air furnaces for house heating are used in such great numbers, especially the smaller sizes, that one would expect a considerable literature on the subject of their economical design, installation and operation. As a matter of fact, there is much less to be found on this subject than on steam and hot water house-heating equipment, largely because of the difficulty of measuring the output from a hot-air furnace. Hence the problem has been much less attractive as a laboratory investigation than problems having to do with steam or hot-water apparatus.

"Mr. Baker's article shows how interesting such problems can be, how really worth while it is for a good engineer to give them careful and ingenious attention. The Bureau of Mines is glad to print such material, which will not only help many users of hot-air furnaces but will also tend to stimulate investigation in his fertile field.

"Husbanding of fuel supplies must be a matter of vital concern to the country. The Bureau of Mines, in its efforts to bring about greater efficiency in the use of fuels, has paid much attention to the improvement of house-heating and boiler-plant equipment and methods of operating them, and has published a number of reports on the subject. Among these are Technical Paper 80, 'Hand-Firing Soft Coal Under Power-Plant Boilers'; Technical Paper 97, 'Saving Coal in Heating Houses'; Technical Paper 199, 'Five Ways of Saving Coal in Heating Houses'; and Technical Paper 205, 'Saving Coal in Boiler Plants.'

"This paper, which was presented by the author before the American Society of Heating and Ventilating Engineers, at Buffalo, N. Y., in June, 1918, points out certain defects in existing types of hot-air heating plants, and suggests a number of improvements in construction and operation that will add to the comfort of the householder and lessen his coal bills."

Copies of this paper may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

THE SAVING of a piece of coal the size of an ordinary egg on each scoopful of coal used in locomotives would amount to 1,500,000 tons a year. Even when firing a freight locomotive on a heavy grade, one less scoopful of coal every 15 min., or one less scoopful every 3 or 4 mi., would effect a similar saving. A little more personal interest on the part of railway officials and employes will reduce coal consumption even on railroads where the practice is already excellent and where an earnest effort is being expended to save coal. A study of the practice in the use of fuel on the railways, however, discloses many means of effecting even greater economy.

The Engineering Experiment Station of the University of Illinois has issued a circular, the title of which is "The Economical Use of Coal in Railway Locomotives," to present some suggestions concerning ways in which large coal savings may be made. The circular is printed in four colors.

The facts presented in this circular have been compiled by a special committee of the research staff of the Engineering Experiment Station, assisted by an advisory committee consisting of E. W. Pratt, Assistant Superintendent of Motive Power, Chicago and Northwestern Railway Company, Chicago; W. L. Robinson, Fuel Supervisor, Baltimore and Ohio Railroad Company, Baltimore, Md.; A. N. Willsie, Chairman, Fuel Committee, Chicago, Burlington and Quincy Railroad Company, Chicago; Timothy Shea, Acting President, Brotherhood of Locomotive Firemen and Enginemen, Cleveland, O.; A. B. Garretson, President, Order of Railway Conductors of America, Cedar Rapids, Ia.; W. S. Stone, Grand Chief, Brotherhood of Locomotive Engineers, Cleveland, O.; O. P. Hood, Chief Mechanical Engineer on Fuel Conservation, U. S. Fuel Administration, Washington, D. C., and C. R. Richards, Dean of the College of Engineering and Director of the Engineering Experiment Station, University of Illinois.

Copies of this circular may be had by addressing the Engineering Experiment Station, Urbana, Ill. The price is 20 cents.

LADEW LEATHER BELTING is the subject of a 108-page catalog just published, part of which is given to a discussion of belt engineering and belt economics, the remainder telling, by picture and explanation, how Ladew belts are made. A copy of this book may be obtained by addressing the manufacturer, Edw. R. Ladew Co., Inc., Glen Cove, N. Y.

YEOMANS BROTHERS CO. of Chicago is describing, in an interesting series of bulletins, its line of bilge pumps, sewage ejectors and pneumatic ejectors. The bilge pumps—Bulletin B-3000—are vertical-shaft centrifugals, electrically driven, arranged to draw from a

cast-iron catch basin, and put up in single or duplex arrangement. Ejectors—Bulletin E-2000—are for mounting in a concrete pit, to draw from a receiver and eject to the sewer; they are of the same general type as the bilge pump, but are always in duplex arrangement. Pneumatic ejectors—Bulletin P-4000—are likewise for location in a pit, but use air pressure as the ejecting force, the action being controlled by cast-iron bells acting against a counterweight as the sewage collects or lowers.

WE ARE ALL familiar with the luminous figures on watch dials that have become so popular during the war. This luminosity, produced by the action of a minute quantity of radium mixed with sulphide of zinc that is stimulated by the radium, can be made use of in various ways for making visible the divisions and hands on gages and meters, signal boards, switches and other apparatus or controls which may need to be reached in the dark. One compound of this sort, Marvelite, is made by the Cold Light Mfg. Co., 558 W. 158th St., New York City, and can be readily applied as a varnish or paint to any object, and a full description of the material, its properties and uses is given in an interesting pamphlet issued by that company.

THE FOURTH EDITION of "The Starrett Book for Machinists' Apprentices," published by The L. S. Starrett Co. of Athol, Mass., has just been issued. The book, now in its thirty-fifth thousand, is a well-illustrated volume of 176 pages, bound in red Athol leather and designed to answer in an authoritative manner questions as to how to do the everyday work of the average machine shop. The different classes of work are taken up separately, the most common errors pointed out and the correct practice indicated. Much attention is given to the proper use and care of tools, the reading of micrometers and verniers, bench work, lathes and lathe tools, grinding, belts, gears, etc. The book is essentially for the apprentice rather than the expert machinist, though the latter will find much of interest and value, and is intended to provide the answers to the many questions usually asked of the foreman or superintendent. Distribution is being made exclusively through the hardware dealers handling the Starrett line of tools, the price being 50 cents a copy.

FOXBORO Power Plant Instruments, Bulletin No. 115, a condensed bulletin briefly covering those indicating and recording instruments manufactured by the Foxboro Co., Inc., that are more particularly fitted for use in power plants, is being issued in the belief that this compact pamphlet will be helpful to those engineers who would not have time to look through the company's larger bulletins.

GIANT Semi-Diesel fuel oil engines are illustrated in Bulletin 34-W, which discusses their three broad features of design: horizontal position of the engines, the use of a crosshead, the use of a hot plate instead of a hot ball or electric ignition. The maker is Chicago Pneumatic Tool Co., Fisher Bldg., Chicago.

BULLETIN NO. 20 of Trade and Industrial Series No. 4, issued by the Federal Board for Vocational Education, Washington, D. C., relates to buildings and equipment for schools and classes in trade and industrial subjects.

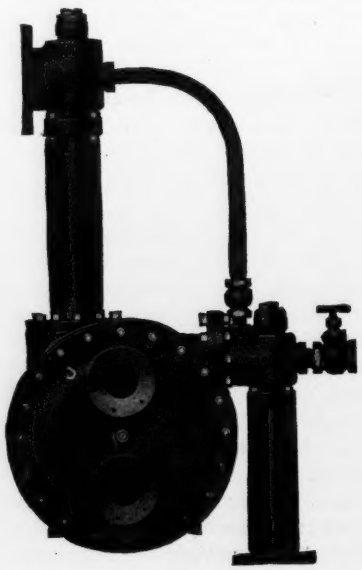
WALTER A. ZELNICKER Supply Co., 325 Locust St., St. Louis, has just issued Bulletin No. 250, which includes a list of power plant equipment. Copies will be sent free of charge to those making application.

BULLETIN 1042-A, of The Electric Controller & Mfg. Co., Cleveland, O., describes and illustrates E. C. & M. automatic compensators for a. c. squirrel-cage motors.

LINK-BELT EQUIPMENT for the Handling and Preparation of Coal at the Mine, Book No. 333, is profusely illustrated and contains 88 pages, covering coal tipples, conveyors, washeries and other equipment used at the mines.

Trade Notes

THE WHEELER Condenser & Engineering Co., of Carteret, N. J., announces that it has obtained from the Schutte & Koerting Co., of Philadelphia, through the



Alien Property Custodian, the exclusive right to manufacture and sell steam jet air pumps under patent No. 968,926, in connection with surface condensers, jet condensers, barometric condensers, vacuum pans and evaporating apparatus. This patent covers the valuable feature of two or more steam jets working in series, with a condenser between the jets—a feature that enables this type of pump to perform a given duty much more efficiently than any steam jet not so equipped. The cut herewith shows this steam jet air pump.

THE WELLMAN-SEAVER-MORGAN CO., of Cleveland, Ohio, has opened a San Francisco office at 415-417 Rialto Bldg., in charge of Norman S. Ross. Business originating from California, Nevada west of the 115th meridian, lower California and the counties of Josephine, Jackson and Klamath in Oregon, will receive the prompt attention of Mr. Ross.